APRIL • 1955

PETROLEUM REFINER

REFINING | PETROCHEMICALS | NATURAL GASOLINE

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Symposia
1. Motor Fuels
2. Urea Complexes
3. Designs on Air

A floating roof is dependent upon its seal to effectively close the space between the rim of the roof and the shell of the tank. The Horton® Seal, standard equipment on all Horton Floating Roofs, is the most effective device ever found for this job. Write our nearest office for information.

CBI

Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston
Los Angeles • New York • Philadelphia • Pittsburgh • Salt Lake City
San Francisco • Seattle • Tulsa
Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PA.

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The view above shows a Horton Double-Deck Floating Roof with its Horton Seal extending above the top of a 64,000 bbl. tank. The Horton Seal is still efficient, in this position, allowing more usable tank capacity for storage. This tank, used to store volatile hydrocarbons, is located at the Utah Oil Refining Company, Salt Lake City, Utah.

3000 impulses help keep mid-west refinery "on stream"

THIS big refinery at Lawrenceville, Ill.—like a lot of other important refineries — uses Yarway Impulse Steam Traps.

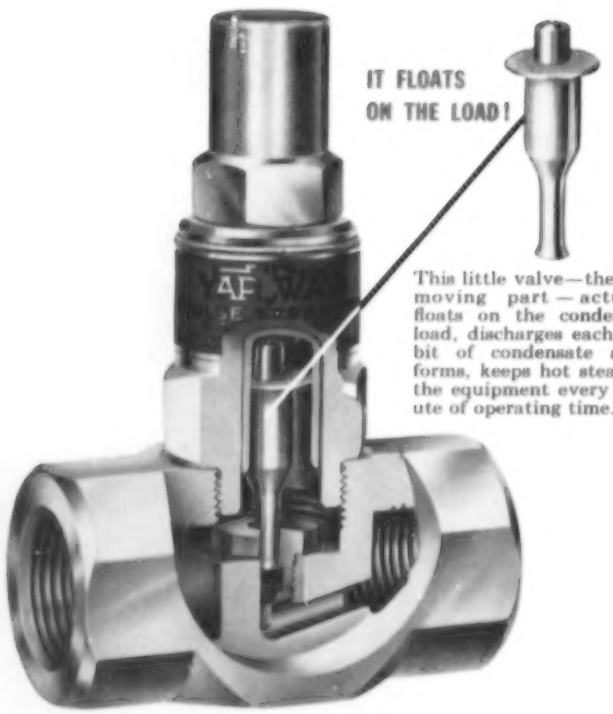
Over 3000 Yarway Impulse Traps are installed on tracer lines and for draining steam headers.

Popular features of the Yarway Impulse Steam Trap are its ability to get equipment *hot in a hurry*—and keep it hot! . . . also its small, handy size—fits in easily in any location; its stainless steel body and working parts; quick installation; easy maintenance; low initial cost.

Another advantage — IMMEDIATE DELIVERY from 250 local distributors, plus quick service from nearby Yarway field engineers.

More than 1,000,000 Yarway Impulse Steam Traps have been sold. For a free Steam Trap Selector, write . . .

YARNALL-WARING COMPANY
128 Mermaid Ave., Philadelphia 18, Pa.



This little valve—the only moving part — actually floats on the condensate load, discharges each tiny bit of condensate as it forms, keeps hot steam in the equipment every minute of operating time.

YARWAY®
impulse®
steam trap

Volume 34, No. 4 April, 1955

PETROLEUM
REFINER
REFINING | PETROCHEMICALS | NATURAL GASOLINE

MOTOR FUEL SYMPOSIUM

Industry Views Motor Fuel Trends 107
Don S. Rawlings, Jr.
Ten Years of Change for Motor Fuel 110
Trends in Automotive Engine Design 112

Rexforming . . . for Octanes Over 100 116
H. W. Grote, V. Haensel and M. J. Sterba
Destrehan Fluid Hydroformer Today 121
R. D. Ferrell, J. R. Tuseon, and H. A. Parker
What's New in Asphalts 125
Walter F. Winters

UREA COMPLEXES SYMPOSIUM

Urea Complexes 127
John J. McKetta
Fundamentally Speaking 128
William G. Domask and Kenneth A. Kobe
How They're Applied 134
Lloyd C. Fetterly

The Solubility of Water in 1-Butene 138
W. B. Brooks and John J. McKetta
Plant for Sale—Should You Bid? 139
Paul L. Weller
Boom Still on for U. S. Ammonia 141
C. H. Davenport
Blends Products in Pipeline 149
Rudy Lowe
Vacuum Flash: Actual Versus Calculated 153
G. A. Filak, H. L. Sandlin, and C. J. Stockholm
Gulf Builds by Functional Analysis 158
William Shay
Ketones from Petroleum 160
Lewis F. Hatch

DESIGNS ON AIR SYMPOSIUM

Short Cut to Air Receiver Design 165
I. T. Fong
Engineering with High Pressure Air 168
J. E. Wilson and E. E. Ludwig
Condition Your Instrument Air 171
R. L. Dockendorff

Taking Stock 182
Cecil W. Smith

As Management Sees It

Here's Why Employes Quit! ..... Willard A. Kerr 104
Why Employes Don't Quit! ..... Al Reese 105
Where Dad Works ..... Al Reese 227
Texas Legislators Embattled Over Gas Prices 230
Investments Abroad Encouraged ..... Robert E. Sparn 234

DEPARTMENTS

Quick Look 4
Letters 89
News and Views 95
Look Box 99
Reviewing New Books 271
How to Do It 184
Who's Building 193
Construction Boxscore 207
What's Happening 249
Men in Industry 261
Heard at Meetings 268
Meetings Calendar 270
Suppliers' Notes 274
Classified Advertising 286
New Equipment 291
New Literature 305
Index to Advertisers 306
Readers Service Card 307

A Quick Look
at This Issue

Busy? Check ✓ those to be read first.

Motor Fuel Symposium—Three Parts

☐ **Industry Views Motor Fuel Trends** . . . Today, 95 to 100 octane gasoline, higher volatilities, and additives vitally concern refining men everywhere. Here are results of a staff-conducted survey of the refining industry on these topics. Page 107.

☐ **Ten Years of Change for Motor Fuel** . . . What has happened to the motor fuel picture in the postwar period? What changes have accompanied the tremendous expansion in production facilities? Here is a round-up of valuable information answering these questions. Page 110.

☐ **Trends in Automotive Engine Design** . . . With gasoline quality requirements tied directly to engine design changes, these trends become increasingly important to the refiner. Page 112.

☐ **Rexforming . . . for Octanes Over 100** . . . This new catalytic reforming process produces super quality gasoline by the use of a solvent extraction technique coupled with recycle of low octane material. It is estimated that a Rexforming installation will cost about $300 per barrel to build and about 36 cents per barrel to operate. Page 116.

☐ **Destrehan Fluid Hydroformer Today** . . . Here's a process unit you may have been wondering about. Installed in June, 1953, the unit has been undergoing extensive testing with a wide range of process variables. Tests indicate that commercial operation is beyond the expectations of pilot plant work in many cases. Page 121.

☐ **What's New in Asphalts** . . . Berry Asphalt has cooperated with several other companies to produce a rubberized asphalt. Rubberizer, composed of synthetic rubber and barytes, can be added in powder form to asphalt mix. It is most timely with the highway construction picture looking so bright. Page 125.

Urea Complex Symposium—Three Parts

☐ **Urea Complexes** . . . A new separation tool which may soon rank with distillation as a major

→ Turn the Page →

method of separating hydrocarbon mixtures. Commonly called "extractive crystallization," this process is being investigated by numerous companies as a potential giant in the separation of complex mixtures. This 11-page, three-article symposium covers the theoretical considerations as well as the practical applications. Numerous questions are answered clearly by the top authorities in this field. Turn now to **Page 127.**

☐ **Fundamentally Speaking** . . . Here is an excellent review of the general properties of urea and thiourea. Which substances form complexes? What are the conditions of formation and decomposition? These questions arise when any systematic application is attempted; you'll find the answers on **Page 128.**

☐ **How They're Applied** . . . Urea and thiourea extractive crystallization offers an invaluable laboratory tool for the separation and identification of certain hydrocarbon types. Commercial urea processes appear to have potential value in the future; in case of a national emergency, for re-distributing the n-paraffins contained in petroleum fractions to yield improved gasoline, jet, and diesel fuels as well as lubricating oils. **Page 134.**

☐ **The Solubility of Water in 1-Butene** . . . Water is as much as three times more soluble in 1-butene than in saturated paraffins such as *n*-butane and propane. In this article you will find experimental data on this system up to 1000 psia and temperatures up to 291° F. **Page 138.**

☐ **Plant for Sale—Should You Bid?** . . . In this case, the plant in question was one of the government-owned styrene plants. Here is the procedure used by one company for gathering information and arriving at a decision. **Page 139.**

☐ **Boom Still on for U. S. Ammonia** . . . Production capacity of synthetic ammonia now approaches 3 million short tons per year while ammonia produced from by-product sources is less than 300,000 short tons. The end is not yet in sight because an additional 1.8 million short tons capacity of synthetic ammonia is proposed for completion before 1957. For a complete review of the ammonia situation, see **Page 141.**

☐ **Blends Products in Pipeline** . . . Here's a revolution in product handling. This blending plant at Shell's Wood River refinery automatically does the blending in the pipeline—eliminating tank gaging, manual switching and pump attendance. **Page 149.**

☐ **Vacuum Flash—Actual Vs. Calculated** . . . If you have wondered how those design calculations on vacuum columns compared with reality, here is a study that will show you. Extensive plant tests were made on three commercial vacuum columns and the results are compared with the results from well-known design methods. **Page 153.**

☐ **Ketones from Petroleum** . . . Production processes, chemical reactions and uses of this important class of petrochemicals are reviewed by Dr. Lewis Hatch. Long established as solvents, ketones are becoming increasingly important materials for the production of other chemicals. See **Page 160.**

Designs on Air—Three Articles

☐ **Short-Cut Method in Air Receiver Design** . . . Use this and you'll have no more use for tedious step-by-step calculations. Here is a one-chart method to cut your calculation time tenfold. See for yourself on **Page 165.**

☐ **Engineering with High Pressure Air** . . . No more wasting your time hunting for properties of air at high pressures and temperatures. Even though you did find the data, they would be presented in an inconvenient tabular form. Here, then, is your own copy of a single pressure-enthalpy chart for high pressure air including specific volumes, temperatures and entropy. You can do your repetitive "trial and error" calculations directly with the chart. **Page 168.**

☐ **Design of Dry Instrument Air Systems** . . . Do your operations suffer from instrument malfunctioning during freezing weather? Use of conditioned instrument air eliminates not only this problem but also reduces instrument maintenance costs. Here is a thorough treatment of the installation of a central conditioned instrument air system at a large refinery, discussing the justification for an operation of the system, and the design of dryers and filters. **Page 171.**

☐ **Here's Why Employes Quit!** . . . It costs your company from $80 to $600 every time an employe quits. So isn't it worth your while to learn why most people quit? Here is a scientific analysis of the WHY of separations in 48 companies, **Page 104.**

☐ **. . . And Here's Why They Don't!** . . . First read the above article on Why Employes Quit! Now find out why they don't. PETROLEUM REFINER asked a cross-section of employes from coast to coast: "What six things would you most like to see in your boss? Almost unanimously, they replied, in effect: "He doesn't need six qualifications. Just one." **Page 105.**

☐ **Investments Abroad Encouraged by U. S.** . . . The government has liberalized its insurance guarantees against currency convertibility losses, exproporiation and confiscation. Not many, however, are taking advantage of the inducement. **Page 234.**

PETROLEUM REFINER

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PETROLEUM REFINER and The REFINERY CATALOG for the refining-natural gasoline-petrochemical industry

WORLD OIL (formerly The Oil Weekly) and The COMPOSITE CATALOG for the drilling-producing industry

PIPE LINE INDUSTRY for the oil and gas pipe line industry

Petroleum Refiner is indexed by Industrial Arts Index, Chemical Abstracts and by Engineering Index, Inc. Microfilm copies available through University Microfilms, Ann Arbor, Michigan.

It's a triple-header . . .

. . . and it's waiting for you farther along in your PETROLEUM REFINER this month! Take a quick look at this:

- **Motor fuels.** Page 107.

  Here, for the first time, is a wrapup of the oil industry's views on the changes occuring in motor fuels.

- **Designs on Air.** Page 165.

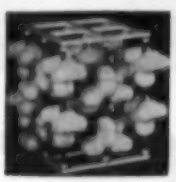
  Here are interesting and helpful hints in the use of air. One article in the symposium deals with the design of air receivers, another with the use of instrument air, and a third covers the properties of high-pressure air.

- **Urea complexes.** Page 127.

  Don't miss this discussion on the new important extractive crystallization process for separation of complex mixtures.

Urea Complexes = Extractive Crystallization

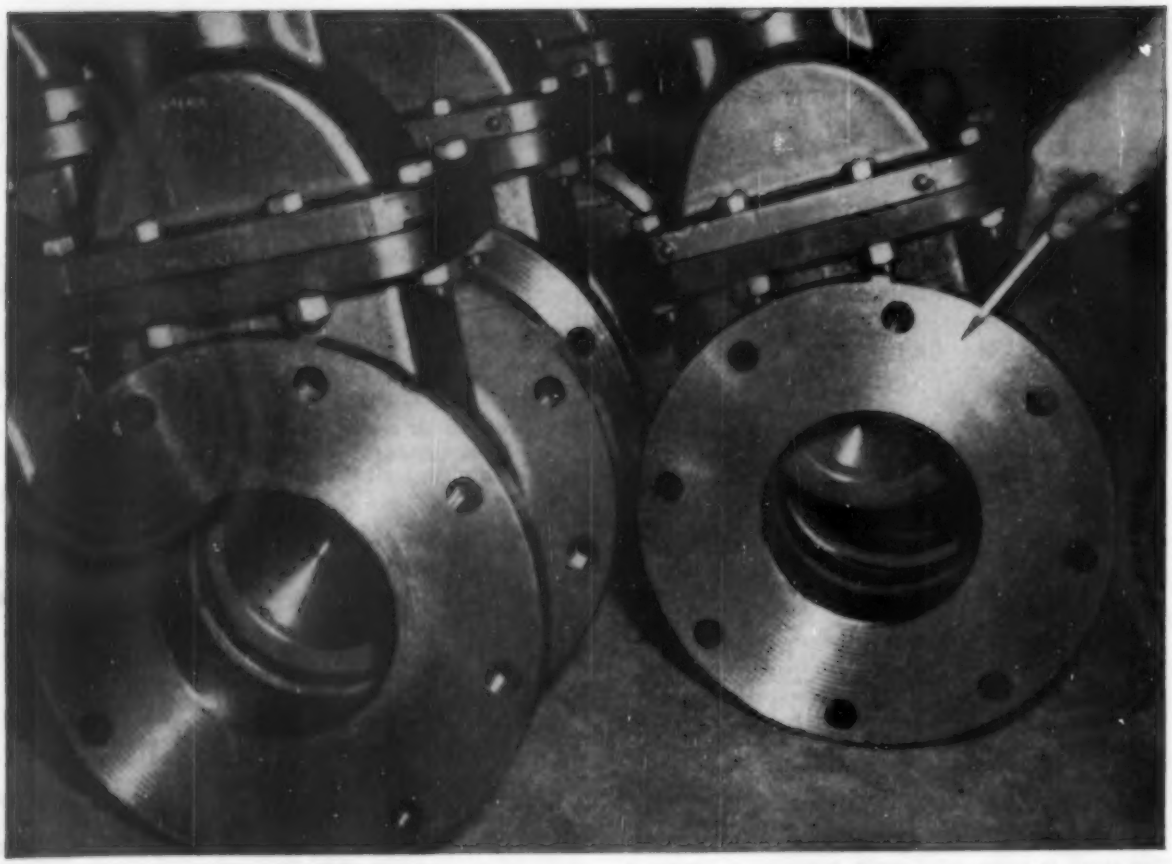
BEGINNING on Page 127 is the symposium giving you the newest facts on this great new development, extractive crystallization. The PETROLEUM REFINER is proud indeed to answer your many questions on this highly important new separation method. We are also proud of our foresight in presenting the story on this subject when it was in the infant stage. Away back in March, May and July of 1952, the REFINER predicted that extractive crystallization would soon command the attention of all those concerned with the separation of complex mixtures.



Now again in 1955, we ask our authors to tell our readers the latest developments in this field. Where can extractive crystallization be used in the refining and petrochemical industry? How can it be used? How does the urea form complex crystals? How is the separation effected? They give you these answers along with many other answers to your questions.

Future Symposia

LOOKING into the PETROLEUM REFINER crystal ball we see in the near future many symposia designed to help you in your work. The first one will be on jet fuels. This will be followed by metallurgy in the refinery, fired tubular heaters, chemical raw materials in the refinery, costs and economics in the refining industry and many more. We will try to continue making the PETROLEUM REFINER the No. 1 technical magazine for you. If you feel we have missed some special subjects drop us a line.



Corrosion handcuffed in alcohol-acid plant. These valves of "HASTELLOY" high nickel-base alloy assure the desired uninterrupted operation between inspections. Produced by Hasco Valve and Machine Co., Milwaukee, Wisc.

Nickel-base alloy stops unscheduled shutdowns

. . . handles 50-60% H_2SO_4 at 200-250°F

Meet some valves that show exceptional corrosion-resistance. They are made of HASTELLOY alloy D, a high nickel-base alloy.

A large oil refinery installed these valves in plants that process and concentrate sulphuric acid, which, in turn, is used for producing isopropyl and ethyl alcohol and ethers.

And here's what this user writes:

"At present, the units are on a four-month scheduled inspection and repair interval. HASTELLOY *alloy D fittings are the only ones available that do not require unscheduled shut downs for replacement and accompanying loss of production between these inspections.*

Scores of users report similar savings where equipment is exposed to strong corrosives.

You, too, may obtain excellent results by using one of the series of nickel-base alloys produced and sold under the trade-mark "HASTELLOY" by Haynes Stellite Company, Kokomo, Indiana, a Division of Union Carbide and Carbon Corporation.

Whatever your corrosion difficulty, make use of our wide practical experience. Send details of your problem for our suggestions. Write us today.

INCO TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC. 67 Wall Street New York 5, N. Y.

You don't save a dime at "Oilwell"—

but you get more for your money!

● We've never met a refinery man yet who would sacrifice quality for price. That's why you'll find "Oilwell" refinery warehouses stocked with only the most reputable equipment and supplies for refining and petrochemical operations.

But this isn't all you get for your money from "Oilwell." The men who specialize in serving our refinery customers have all had actual experience with refineries, refinery contractors or pump manufacturers. They know refinery material and the service you require.

See how this system can help you.

Quality products—"Oilwell" stocks include the best known brand names in equipment and materials designed and approved for refinery operations. When it comes from "Oilwell," you know it will meet your specifications.

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Complete warehouse system—Well-stocked warehouses are conveniently located to serve the important refining centers. Inquiries are given prompt attention and deliveries are made quickly to meet your emergency requirements.

Experienced personnel—"Oilwell" refinery specialists, having been trained in refining and petrochemical plants, understand your material and service problems and can give you the service you require.

92 Years of experience—From almost the beginning of the petroleum industry, "Oilwell" has worked with the men engaged in drilling and production. Our goal is to extend the same prompt, dependable and complete service to those responsible for Refining and Petrochemical operations.

These famous products are sold by "Oilwell"

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and many others

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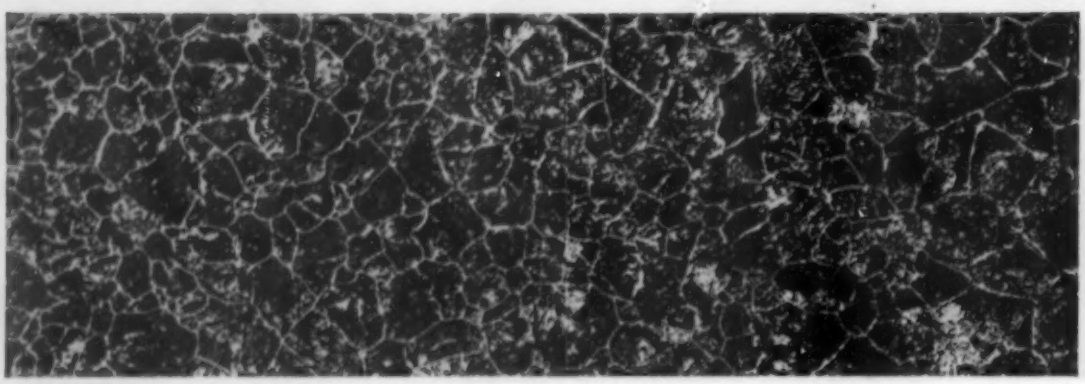
INDIVIDUAL HANDLING . . . one good reason

TIMKEN® forging steels give uniform



grain size order after order

THERE are good reasons for the uniform grain size in every piece of Timken® forging steel, as shown in the photomicrograph above. And good reasons, too, why you get the grain size you want order after order.

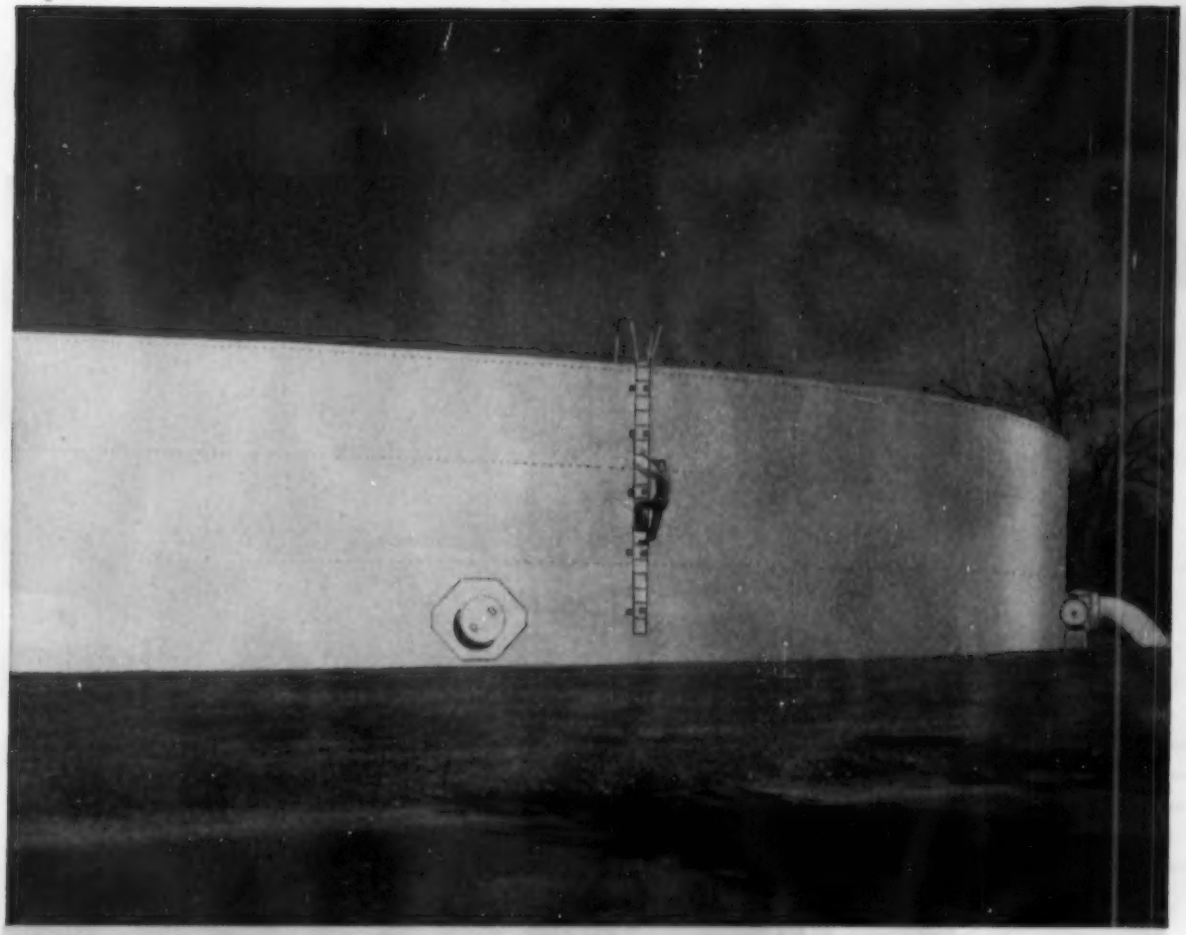
Your order for Timken forging steels is handled individually in our mills and we target conditioning procedure to your particular forging requirements. In the top photo, a billet is stamped to identify the heat and ingot it came from—one way we can make sure you get uniform grain size from shipment to shipment.

Uniform grain size after heat treatment is assured by spectrometric or microscopic examination of every heat. The result—you can be sure that forgings made from Timken forging steels have uniformly high ductility and resistance to impact.

You have fewer furnace temperature adjustments when you use Timken forging steels. Every lot responds uniformly to heat treatment because every lot has the same physical and chemical properties. Always specify Timken forging steels. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING



KUHN ALUMINUM PAINT
in excellent condition
after 8 years' service
on Houston Water Tank

▲ This storage tank, located on 19th Street in Houston, was painted by Ace Service Company, subcontractor for Chicago Bridge & Iron Company. It was primed with Kuhn's #447 Tankote Red Primer, followed by two coats of #148 Paste Based Aluminum. **Aluminum Paint**, by Kuhn Paint Company, Houston, Texas.

Corrosive Gulf Coast atmospheres have had little effect on this huge water storage tank owned by the Utilities Department of the City of Houston, Texas. It was painted with aluminum in December, 1946, and a recent inspection showed that after more than eight years the paint was still in very good condition.

The Gulf Coast area is conceded to be especially hard on metal and paints . . . making a service record like this an outstanding example of aluminum paint's durability and economy.

ALCOA does not make paint, but ALCOA Aluminum Pigments are used in more aluminum paints than any other brand. Special formulas have been developed by your paint manufacturer to solve individual problems. Paints made to these formulas actually cost less, last longer, give utmost protection against heat, cold, sun, rain, smoke and fumes. Write today for our informative, FREE booklets. They have the latest information on all types of aluminum paints. Use the coupon.

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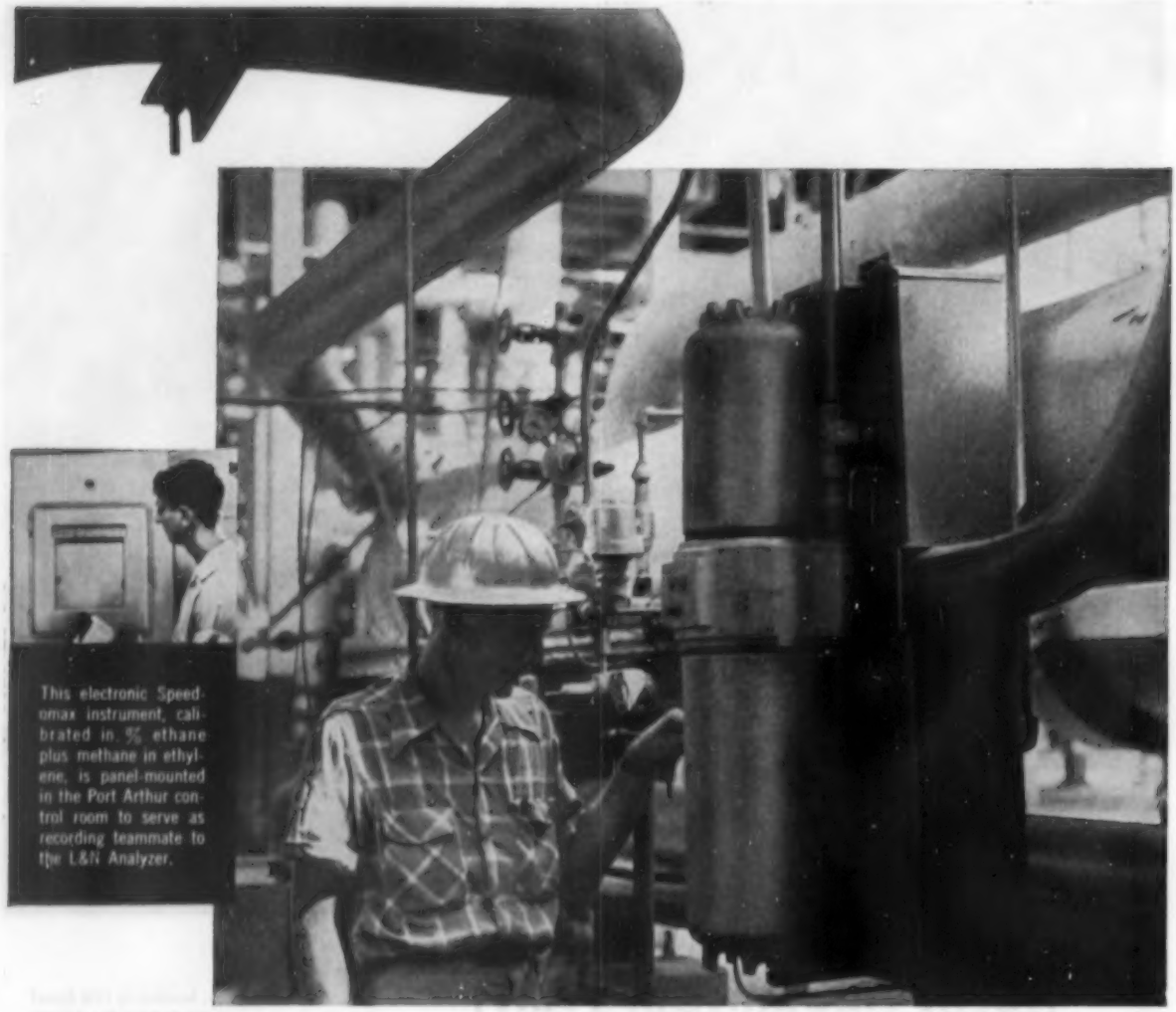
For more data on advertised products, use Readers' Service Cards, last page.



This electronic Speedomax instrument, calibrated in % ethane plus methane in ethylene, is panel-mounted in the Port Arthur control room to serve as recording teammate to the L&N Analyzer.

Infrared analysis helps Gulf to pipe "on spec" ethylene directly to consumers, without tankage or sampling

There's no costly storage—no laborious sampling or blending before shipment of the high-purity ethylene produced at Gulf Oil's Port Arthur Refinery. Operators are *certain* that the plant stream is always "on spec", as it runs from production directly to pipelines serving the ethylene-hungry industries of the Houston—Sabine River—Port Neches area.

One reason for such confidence in product quality is the L&N Infrared Analyzer that Gulf has installed to constantly monitor impurities in the ethylene stream. Should the sensitive Analyzer detect a predetermined percentage of impurity, operators can promptly divert "off spec" stream before "on spec" product in the lines can be contaminated.

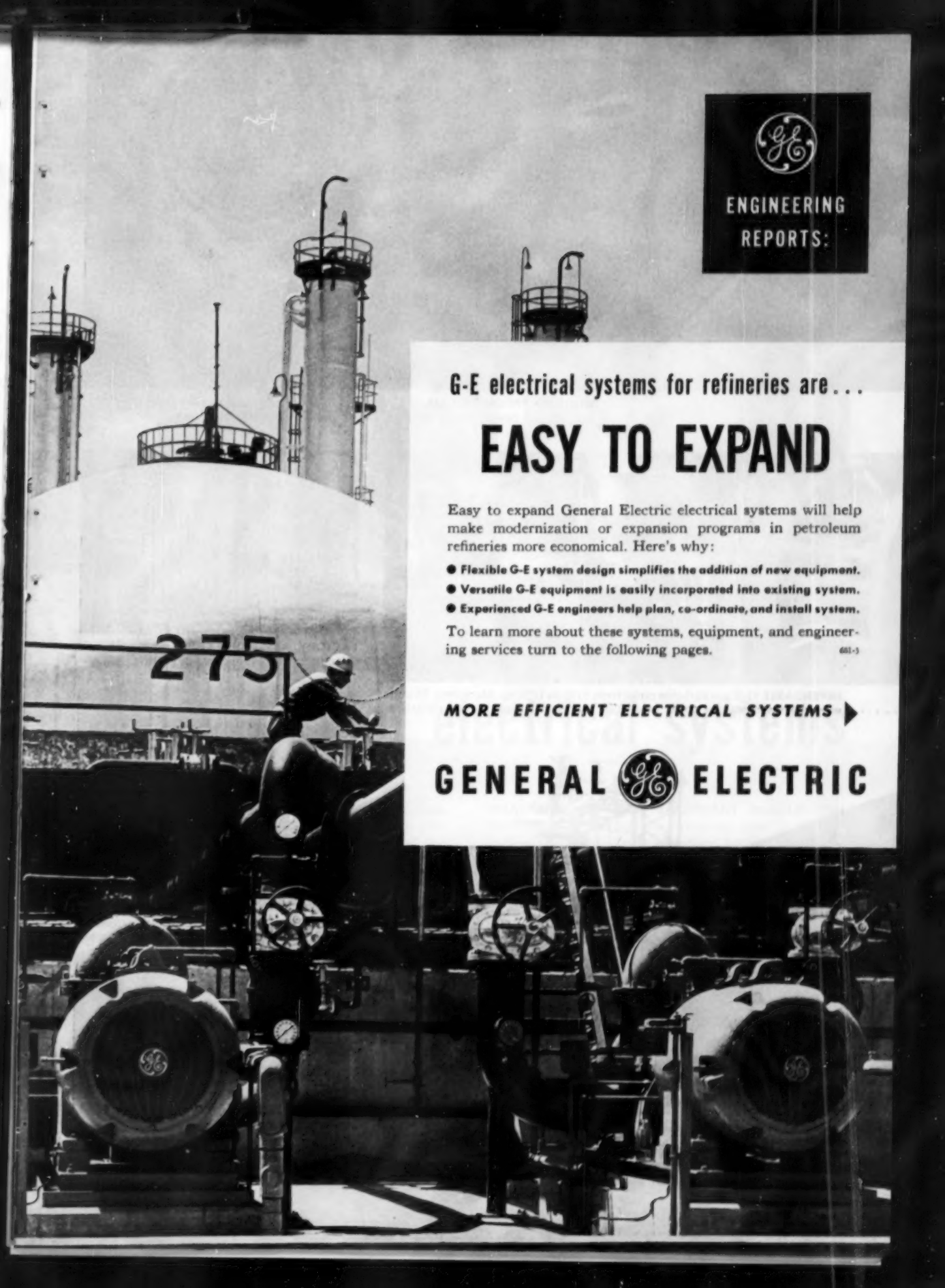
Even though subjected constantly to the vibrations of a pipeline mounting, and electrical pick-up from pumps and compressors, the Analyzer checks consistently with daily spectrometer analyses—a tribute to the L&N instrument's all 'round dependability.

The Analyzer's prominent role at Port Arthur is duplicated in many other successful applications of this versatile instrument. It's measuring CO and CO_2 in the steel industry—SO_2 in H_2SO_4 stack gas—methane build-up in ammonia production—isobutane loss in petroleum. It may well be the yardstick *you* need in your own gas measurements.

Our Applications Lab is staffed with specialists glad to discuss your use of infrared. Outline your requirements, without obligation, in the Infrared Analysis Data Sheet we'll mail on request. Or, just write for our Demonstrator, "How the L&N Infrared Gas Analyzer Works." The address is Leeds & Northrup Co., 4923 Stenton Ave., Phila. 44, Pa.

LEEDS N NORTHRUP

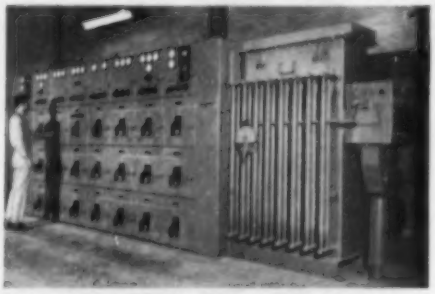
Instruments — *automatic controls • furnaces*


ENGINEERING
REPORTS:
G-E electrical systems for refineries are . . .
EASY TO EXPAND
Easy to expand General Electric electrical systems will help make modernization or expansion programs in petroleum refineries more economical. Here's why:
● Flexible G-E system design simplifies the addition of new equipment.
● Versatile G-E equipment is easily incorporated into existing system.
● Experienced G-E engineers help plan, co-ordinate, and install system.
To learn more about these systems, equipment, and engineering services turn to the following pages.
GEA-5
MORE EFFICIENT ELECTRICAL SYSTEMS
GENERAL ELECTRIC

UTILIZING PROCESS STEAM, G.E.'s complete range of steam turbine-generators provide electric power as a by-product, help maintain plant steam balance.

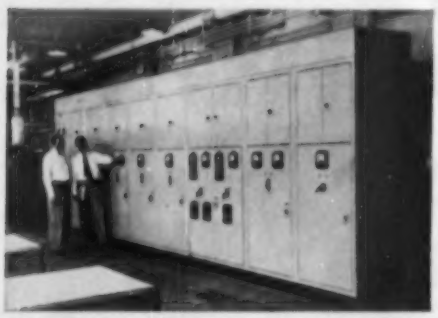
DEPENDABLE G-E gas turbines range from 6700 to 1700 hp. More than 55 units utilize exhaust heat for power generation and mechanical drive applications.

MORE RELIABLE POWER DISTRIBUTION is available with G-E package substations which use co-ordinator transformers, metal-clad switchgear.



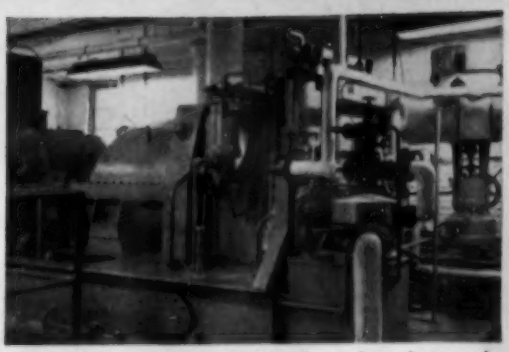
FACTORY ASSEMBLED G-E load center unit substations help cut installation time.

COMPLETE, COMPACT, G-E motor control centers provide centralized control in load areas.



SAVE FLOOR SPACE with compact G-E Limit-amp control units.

DEPENDABLE G-E d-c motor generator sets are designed to operate in continuous service at top efficiency. Minimum of maintenance is a key feature of these sturdy generators built for long life.



ECONOMICAL MAINTENANCE is a key feature in design of G-E mechanical drive turbines.

RUGGED CONSTRUCTION of G-E Tri-Clad* motors make them ideal for all types of drive operations. Polyex insulation in motors 100-3000 hp gives 50% longer motor life. *Reg. Trademark of General Electric Co.

G-E engineering services, equipment can give you . . .

More efficient electrical systems

MODERNIZING, EXPANDING, BUILDING? Whatever your plans, let experienced G-E engineers help plan a more efficient electrical system for you. They will work with you or your engineering contractors to give you correct answers to the following questions.

SHOULD YOU GENERATE OR PURCHASE POWER? G-E engineers will help make a "load" survey of your facilities, and recommend an economical solution to your particular power supply problem.

WHAT TYPE ELECTRICAL DISTRIBUTION SYSTEM SHOULD YOU INSTALL? The latest distribution system concepts will be reviewed with you by G-E engineers. They will help select and design a modern system to meet your individual requirements.

WHAT KIND OF DRIVE EQUIPMENT SHOULD YOU USE? Each application for drives in your processing lines will be individually examined by G-E engineers to assure that the proper drive is designated for the job.

WHERE CAN YOU UTILIZE AUTOMATIC CONTROLS? New developments in the field of automatic controls will be applied throughout your processing lines by G-E engineers.

Let your General Electric Apparatus Sales Representative get you detailed answers to these and other electrical questions. Contact him at your nearest G-E Apparatus Sales Office early in your planning stages. General Electric Company, Schenectady 5, N. Y. 681-3

PROTECT YOUR EQUIPMENT INVESTMENT ▶

Engineered Electrical Systems for Process Industries

GENERAL ELECTRIC

SIX G-E ENGINEERING SERVICES . . .

HELP YOU PROTECT YOUR EQUIPMENT INVESTMENT

1 **G-E APPLICATION ENGINEERING** helps you and your consultants design the right electric system for your plant.

2 **G-E ANALYTICAL ENGINEERING** helps attain the optimum electrical system for your application. Engineering experience backed up by electronic system analyzers save valuable design time.

3 **G-E PRODUCT DEVELOPMENT** laboratories design and test new equipment under tomorrow's conditions to meet your future demands.

4 **G-E FIELD-SERVICE ENGINEERING** helps you supervise installation, expedite start-up of your major electric equipment.

5 **G-E MAINTENANCE SERVICE** from 31 G-E Service Shops will repair and uprate your old equipment, help establish productive maintenance of your equipment, furnish emergency service.

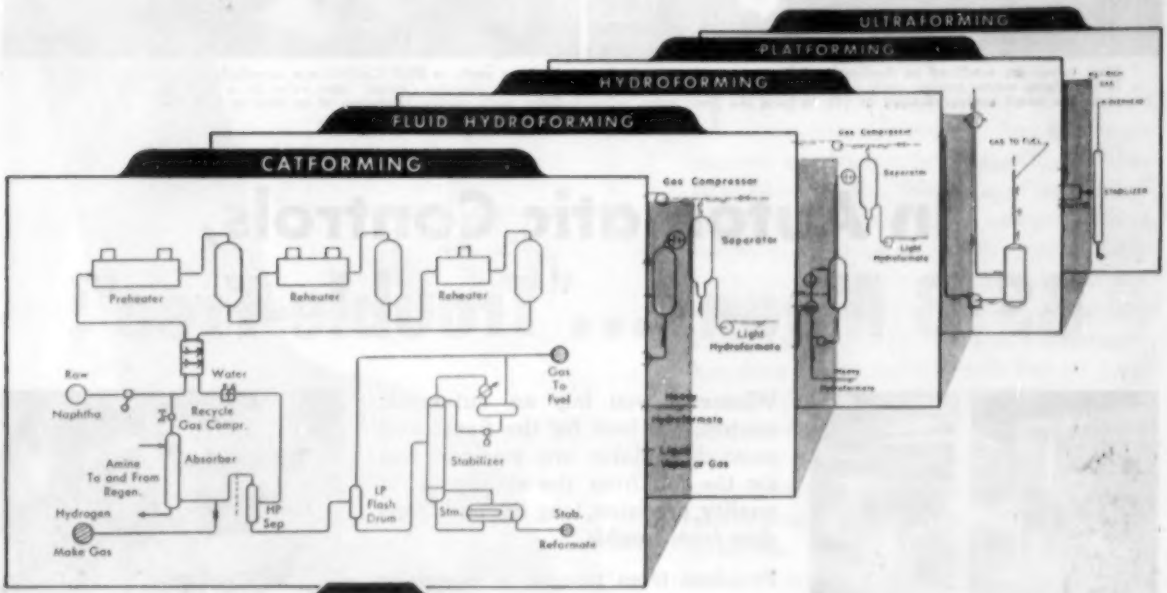
6 **G-E PROJECT CO-ORDINATION** means on-time engineering, shipment, installation of your electric equipment from preliminary diagrams through start-up.

These valuable services are available to you with General Electric equipment. Contact any General Electric Apparatus Sales Office. Meanwhile, for the full story of G-E engineering services, write for brochure GED-2244, General Electric Co., Sect. 681-3, Schenectady 5, N. Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC

which method of
CATALYTIC REFORMING
is best suited to your needs
...FLUID or FIXED BED?



Here's why FW can give you the right answer

...and supply the complete job, too!

The success of catalytic reforming has led to the development of many different methods — both fluid and fixed bed. Selection of the most economical and efficient process for any given installation therefore poses an interesting problem.

Foster Wheeler has completed an extensive economic study of the relative values of the fluid method of catalytic reforming versus the various fixed bed methods. It was found that each has its merits . . . and its limitations. Proper selection depends on plant size, quality of charging stock, octane requirements and other factors.

Our wide design, engineering and construction experience in both fluid and fixed bed catalytic reforming is at your service. *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

FOSTER WHEELER

For more data on advertised products, use Readers' Service Cards, last page.

Inner valves are machined on duplicating lathes to exacting standards. In this photo, master contour plate on lathe at (A) automatically duplicates the exact contour desired at (B) to form the inner valve.

Precision parts on BS&B Controls are manufactured to close tolerances. This lathe operator "mikes" inner valve for a final tolerance of .001". Other parts require tolerances of as little as 3/10,000"

In Automatic Controls, BS&B Means..."Trouble-Free"!

Ample production facilities and stocks of material assure prompt deliveries on all standard items in the BS&B Controls line.

Whenever you buy an automatic control, you look for the finest and most dependable one you can find for the job from the standpoint of quality, precision, long life and *"freedom from trouble."*

Freedom from trouble is especially important, because once a control is installed in the line, any "down-time" caused by its faulty operation becomes very expensive—usually many times more expensive than the entire cost of the control itself.

That's why it *always pays* to specify and buy BS&B Automatic Controls! Because of their superior quality and their long trouble-free performance, they'll *pay for themselves* in almost no time!

A Sinusoidal waveform apparatus is used to check the accuracy and performance of a BS&B Type 1440 Pressure Control Pilot.

Proper treating and hardening of certain component parts of BS&B Controls in one of these precisely controlled electric annealing furnaces is just one of the important manufacturing operations which assures their high quality and long trouble-free service.

Every BS&B Control must pass rigorous operating tests in our modern hydraulic testing and experimental laboratory. In this view, valves in the line are under test pressures from hydraulic pumps in the foreground. Operator checks readings on the control panel for valve performance.

EFFICIENCY OVER 60 YEARS BS&B RELIABILITY

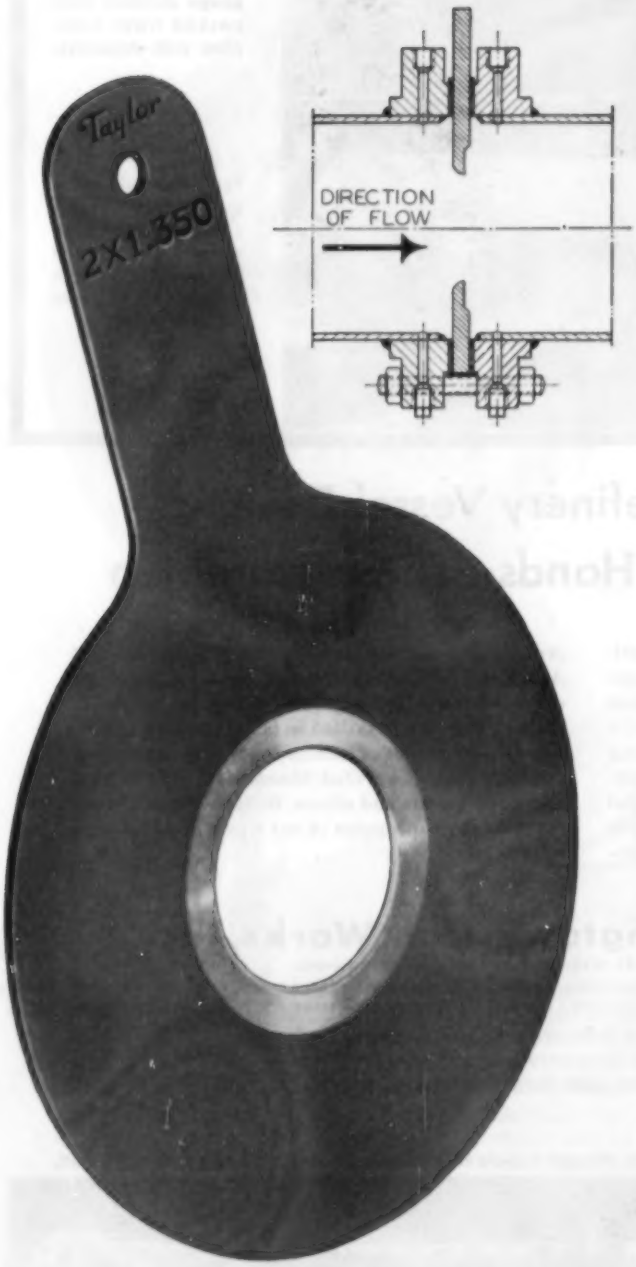
BLACK, SIVALLS & BRYSON, INC.

84 Sales Centers — Controls Division, Dept. 4-F4 — 40 Stocking Points

7500 East 12th Street, Kansas City 26, Missouri

New improved measurement of

LOW FLOWS WITH VARYING VISCOSITY



AS A RESULT OF TAYLOR'S BROAD EXPERIENCE WITH QUADRANT EDGED ORIFICE

THE Quadrant Edged Orifice is the result of considerable effort to find a primary element suitable for low Reynolds number flow measurement. This type of flow is encountered when viscosity is a factor both in magnitude and variation. The orifice edge has a rounded approach on its upstream face making it practically insensitive to viscosity changes so long as the throat Reynolds number does not exceed 250,000. For all practical purposes it has a constant coefficient over the Reynolds number range of 5000 to 250,000. Calibration curves are therefore unnecessary—standard square root charts can be used even on low flows. This constant coefficient characteristic permits the use of an integrator in the recorder or a planimeter with the charts.

Our experience has shown that unusual machining skills are required to produce this type of orifice satisfactorily—the edge contour being extremely important. If you have flow measurement problems that could benefit from the use of this Quadrant Edged Orifice, we suggest you submit them to Taylor for analysis and recommendation. Meantime write for technical bulletin to Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada.

• • •

Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.

Taylor Instruments MEAN ACCURACY FIRST

For more data on advertised products, use Readers' Service Cards, last page.

Refinery tower built at Downingtown of 20% type 316 stainless clad steel. Dimensions—7'0" I.D. by 83'4" overall. Equipped with 38 #10 gauge stainless steel packed trays complete with chimneys.

Synthetic crude tower equipped with 23 support rings to accommodate bolted bubble trays. Carbon steel—7'6" diameter by 85'7" overall.

Your Complex Refinery Vessel Designs are in Experienced Hands at Downingtown

Our Engineering Department is thoroughly experienced in translating your complex designs into accurate, smooth-working pressure vessels for modern refinery processes. Our past experience with hundreds of such vessels may point the way to tested construction methods which can save you money.

Downingtown engineers have developed special welding procedures which produce sound welds that are extra-strong and extra-neat. Welding procedures and fabricating and testing methods meet ASME and API-ASME Codes. Authorized insurance company inspection regularly available.

Downingtown is skilled in fabricating and welding various grades of carbon steels, stainless steels, stainless clad, nickel clad, Monel clad, cupro-nickel and other metals and alloys. Bulletin PF tells more —shows more examples of our work. Send for your copy today.

DOWNINGTOWN IRON WORKS INC.

Downingtown Iron Works, Inc.

151 Wallace Ave., Downingtown, Pennsylvania

New York Office: 52 Vanderbilt Avenue, New York 17, N. Y.

HEAT EXCHANGERS • TOWERS • PRESSURE VESSELS • STORAGE TANKS • STEEL AND ALLOY PLATE FABRICATION

DIVISION OF, Pressed Steel Tank Company

Manufacturer of Hackney Products, Milwaukee 14, Wisconsin

Hackney

CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

Carbon steel gasoline refractionator, equipped with 20 flanged bubble trays. Dimensions—2'0" I.D. by 49'3" overall.

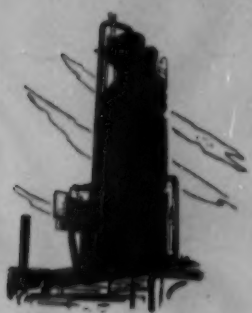
REYNOLDS ALUMINUM
is on the job from
FIELD to REFINERY

REYNOLDS OIL COUNTRY PIPE

for temporary water, gas, air and mud lines.

ALUMINUM HEAT EXCHANGER TUBING

arrests corrosion—saves equipment and labor.



ALUMINUM JACKETING

on towers and piping couples utility with beauty.

ALUMINUM TANKS

resist corrosive solutions and atmospheres.

FOR TOMORROW

Aluminum, truck-mounted, mobile drilling rigs.

LIGHT WEIGHT, resistance to corrosion and rust, durability and ease of fabrication are factors that enable Reynolds Aluminum to serve the petroleum industry better. Experience in practical use has proven aluminum ideal for broad petroleum applications—continuing research and study by Reynolds is producing more and more profitable new uses for tomorrow.

The staff of Reynolds regional offices includes engineering specialists to help you save time, money and labor with aluminum chemicals, shipping containers and mill products. A fully integrated technical staff at Reynolds headquarters is available for further consultation. For information call your nearby Reynolds office listed under "Aluminum" in the classified telephone directory, or write *Reynolds Metals Company, 2598 South Third Street, Louisville 1, Kentucky.*

See "Mister Peepers", starring Wally Cox, Sundays on NBC-TV

REYNOLDS ALUMINUM

MODERN DESIGN HAS ALUMINUM IN MIND

WITH

BENSON ALUMINUM DRUMS

1 Save on replacement costs! Strong, lightweight aluminum drums outlast and outperform shipping containers made of other materials . . . offer tremendous savings on replacement costs alone. They do not rust or shatter. They stand up under rough treatment. In addition, aluminum drums have a high salvage value.

2 Save on labor and material costs! With the elimination of rust problems go the tremendous labor and material expenses of applying inside enamel and sealer coatings . . . baked-on linings . . . rust-proofing . . . re-tinning . . . galvanizing . . . and other costly formulas and preventatives. You can forget drum maintenance and service and use rust-proof Benson Aluminum drums as they are for years and years.

3 Save on shipping charges! To ship a carload of glycerin in heavy-metal drums from Chicago to Philadelphia would cost $558.90 . . . in Benson Aluminum Drums it would cost only $512.95. This saving of $46 means that every eleventh carload is shipped without additional cost. Remember, too, that lightweight Benson Aluminum Drums also reduce handling costs for you and your customers.

4 Save on your chemical investment! Your shipments are safe against rust, contamination and spoilage when they go in rust-proof Benson Aluminum Drums. You eliminate the possibility of costly damage suits and claims. Aluminum drums protect both your shipment and your customer good will . . . and save money and worry.

USE BENSON ALUMINUM DRUMS TO SHIP: Acids, alcohols, aniline, fats and oils, liquid fertilizers, formaldahyde, hydrazine, hydrogen peroxide, inflammables and explosives, insecticides and poisons, premium petroleum products, propellants and many other liquid products. Also, non-regulatory dry chemicals, powdered food products, naval stores, waxes, greases, soaps and other dry solids.

For further information, contact the Reynolds office listed under "Aluminum" in your classified telephone directory, or write direct to Reynolds Metals Company, 2598 South Third St., Louisville 1, Ky.

REYNOLDS ALUMINUM

EXCLUSIVE SALES AGENTS FOR BENSON CHEMICAL DRUMS

ask the man from Layne

he carries knowledge from many countries under the hat he wears!

The pooled knowledge gained from experience the wide world over is carried under the hat worn by the man from Layne.

A problem solved in Paris, France, may be the answer to a similar problem in Paris, Tennessee. This hard earned factual knowledge is available without cost or obligation to industry, agriculture and municipality.

It's sound business judgment on any question relating to water to "ask the man from Layne."

LAYNE & BOWLER, INC.
Memphis 8, Tennessee

Layne Associate Companies throughout the world

water wells • vertical turbine pumps • water treatment

SPECIAL INDUSTRIAL CONCRETES made with LUMNITE*

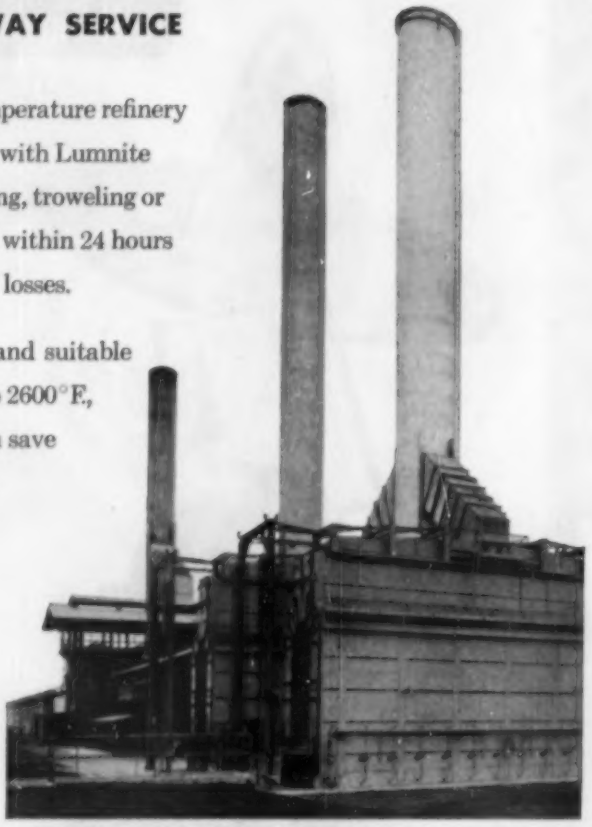
help solve heat, corrosion and insulation problems—FAST!

PLACE THEM 3 WAYS FOR 3-WAY SERVICE

Speed up construction and repair work on high-temperature refinery installations with special industrial concretes made with Lumnite calcium-aluminate cement. Easily placed—by pouring, troweling or cement gun—these concretes reach service strength within 24 hours ... help reduce downtime and minimize production losses.

Industrial concretes made with Lumnite cement and suitable aggregates give you 3-way service—resist heat up to 2600°F., resist corrosion, and *insulate* as well. Often you can save valuable time and cost by specifying one concrete that will do several jobs.

For added convenience, you can use prepared castables (packaged mixes of Lumnite cement and aggregates selected for specific temperature and insulation requirements—add only water). They're made and distributed by leading manufacturers of refractories.



LONGER-LASTING LININGS—These Universal Oil Products Company heaters and stacks have special Refractory Concrete linings made with Lumnite Cement that resist heat and corrosive effects of condensate.

USE SPECIAL INDUSTRIAL CONCRETES FOR:

1. **REFRACTORY INSULATING CONCRETE**—in strippers, rerun chambers, reactors, regenerators, fractional distillation and thermal alkylation units.
2. **ABRASION-RESISTANT REFRACTORY CONCRETE**—Catalyst transfer and discharge lines, reforming chambers, gas coolers, reactor cyclones and transfer lines, regenerator cyclones and return lines.
3. **REFRACTORY CONCRETE**—in bubble and flash towers, continuous-pressure stills.
4. **CORROSION-RESISTANT AND REFRACTORY INSULATING CONCRETE**—linings in regenerator exhaust lines, stacks, ducts.
5. **CORROSION-RESISTANT CONCRETE**—in linings for sweetening and storage tanks, waste-disposal systems, and trenches.

FOR MORE INFORMATION

write Lumnite Bureau, Universal Atlas Cement Company (United States Steel Corporation Subsidiary), 100 Park Avenue, New York 17, New York.

OFFICES: *Albany, Birmingham, Boston, Chicago, Dayton, Kansas City, Minneapolis, New York, Philadelphia, Pittsburgh, St. Louis, Waco.*

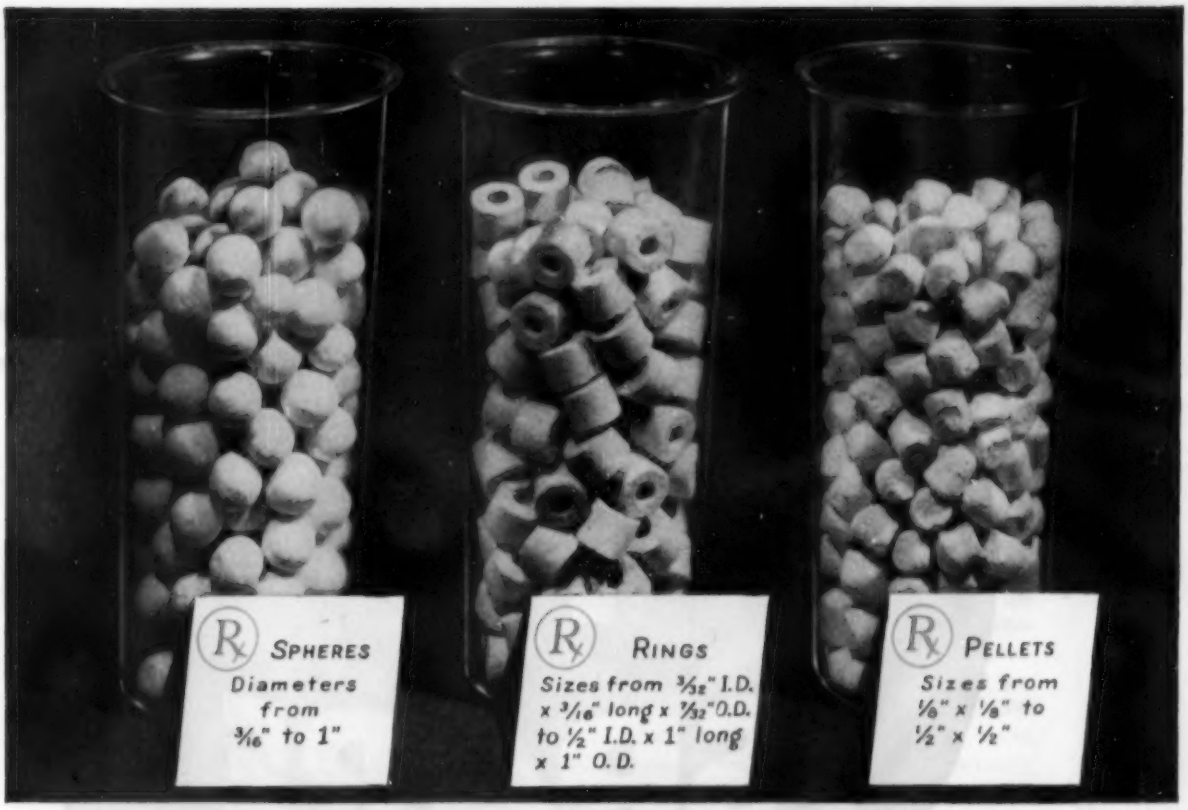
**"LUMNITE" is the registered trade-mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.*

PR-L-104

ATLAS® **LUMNITE for INDUSTRIAL CONCRETES**

REFRACTORY, INSULATING, OVERNIGHT, CORROSION-RESISTANT

UNITED STATES STEEL HOUR—Televised alternate weeks—See your newspaper for time and station.


℞ SPHERES
Diameters from 3/16" to 1"
℞ RINGS
Sizes from 3/32" I.D. x 3/16" long x 3/32" O.D. to 1/2" I.D. x 1" long x 1" O.D.
℞ PELLETS
Sizes from 1/8" x 1/8" to 1/2" x 1/2"

What are your catalyst carrier applications?

Norton engineered and prescribed carriers offer you important processing advantages

What do you need? An inert, high alumina carrier for fixed bed oxidation reactions — such as those involved in the manufacture of phthalic anhydride, maleic anhydride and ethylene oxide?

An inert, low density carrier for use as a space filler or tower packing?

Norton ALUNDUM* fused alpha alumina carriers are proving highly successful in such processes. Containing 77% to 89% alumina, they are outstanding for chemical stability and resistance to abrasion and erosion — and their low density is a valuable quality in packing and filling applications.

ALUNDUM carriers are commercially available in the form of spheres, rings and pellets. Also available in experimental quantities are carriers made of MAGNORITE*, CRYSTOLON*, Fused Stabilized Zirconia and Kyanite materials.

ALUNDUM Spherical Carriers

provide uniform beds in catalytic converters, reducing channeling and pressure drop to a minimum. Medium porosity spheres (40%-44%) have a network of open pores on the outside surface only. These are specifically recommended for applications where the carrier is coated with a catalyst. High porosity spheres (45%-49%) have an internal as well as external network of pores, and are suitable for applications where the carrier is impregnated with a catalyst.

Other Norton Refractories

for chemical processing include porous mediums, laboratory ware, ALUNDUM, MAGNORITE, CRYSTOLON, and Fused Stabilized Zirconia shapes. All are *engineered and prescribed* to give you the best possible ℞ — the most effective combination of physical characteristics plus thermal, chemical and electrical properties. For details call in your Norton Refractories Engineer, or write, mentioning your specific requirements to NORTON COMPANY, 463 New Bond St., Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Canada.

NORTON

REFRACTORIES

Engineered... ℞ ... Prescribed

Making better products... to make your products better

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries

For more data on advertised products, use Readers' Service Cards, last page.

AIR
TO
SPARE

...that's the secret of

CLARK TURBO-*SUPER*CHARGING

Obviously, any turbocharged 2-cycle engine must be supercharged. The extent to which it is supercharged is dependent on the volume of air and the pressure level maintained.

There's air to spare in Clark Turbocharged Compressors, even though a supercharging pressure of 6 psig is maintained at rated load and increased to 10 psig at maximum load.

Elevated pressures alone are not enough. While high pressure is desirable to increase power output, it must be accompanied by a sufficient volume of air: (1) To insure thorough scavenging with a cool, pure air charge for efficient combustion; (2) To thoroughly cool the power cylinder walls for proper lubrication of pistons, rings and cylinder walls.

Conversely, lower pressure supercharging reduces potential power output or results in "highly optimistic" ratings.

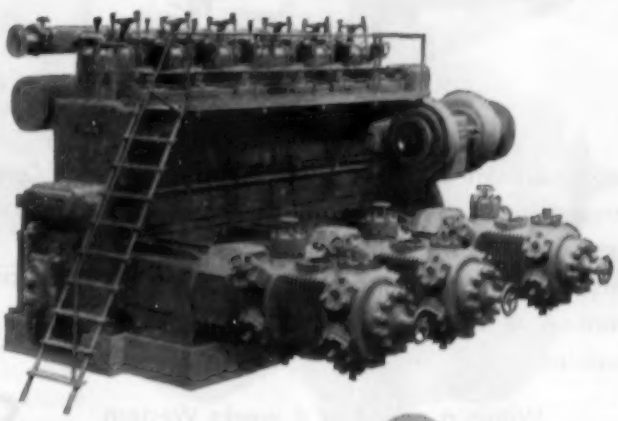
The only practical way to turbo-supercharge, therefore, is to provide a substantial volume of air at elevated pressures and to maintain the volume in proportion to the load placed on the engine. *That's precisely what Clark Turbo-Supercharging does!* The unusually high efficiency of the Clark Turbocharger permits pumping air at sufficient pressure and volume so that power output per cylinder can be increased from 33 to 65% over comparable non-turbocharged units, while cylinder wall temperatures are actually reduced.

Economical to install and operate, Clark Turbocharged Compressors are built in 8 sizes covering an 1100 to 3300 BHP range. Your nearest Clark representative has complete details. Write for Bulletin 134.

CLARK BROS. CO. • OLEAN, N. Y.
ONE OF THE DRESSER INDUSTRIES
Sales offices in Principal Cities throughout the World

CLARK

COMPRESSORS

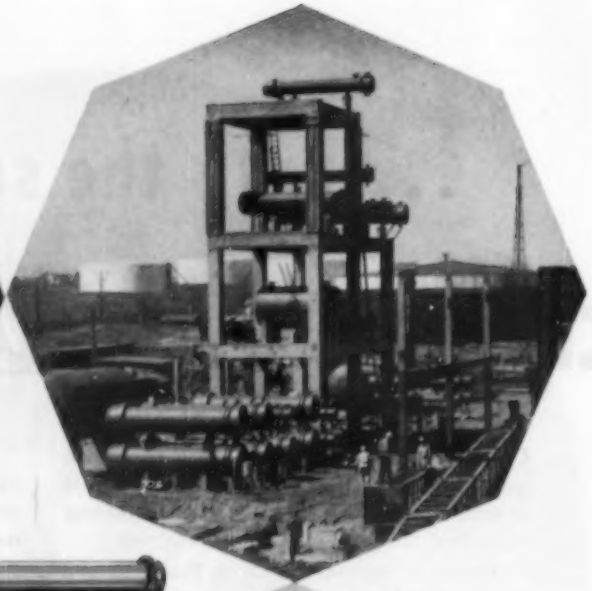


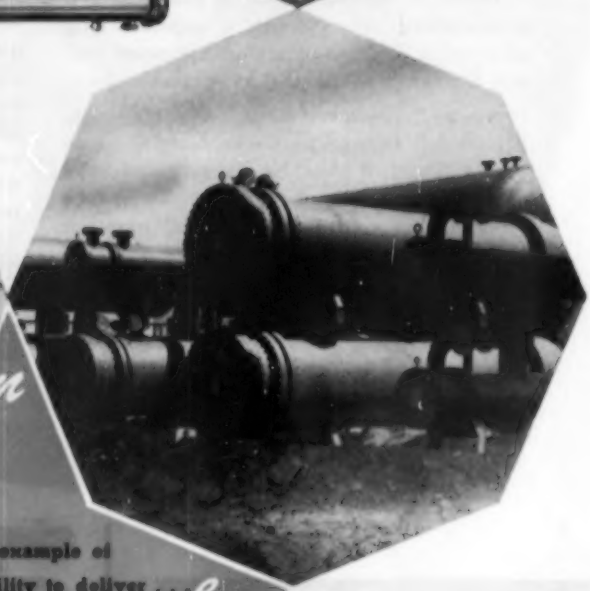
Clark sets the pace in compressor progress

75 1880—1955 YEARS

For more data on advertised products, use Readers' Service Cards, last page.

SUNRAY
NATURAL POWER
OILS





Another example of Western's ability to deliver . . . on time!

Shown above are Western heat exchangers installed in the Coking Unit superstructure at Sunray's Duncan, Oklahoma refinery. These photographs need no further explanation to men familiar with construction schedules.

Within a period of 8 weeks Western delivered all of the exchangers for The Lummus Company-built Coking Unit. . . The Refinery Engineering Company-built Platforming Unit. . . plus 19,000 square feet of Main Column Condensers for the Universal Oil Products Cat-Cracker.

For this one Sunray investment program — 46 heat exchangers from Western Supply Company aggregating a half million dollars worth of equipment.

WESTERN
HEAT EXCHANGERS
WESTERN SUPPLY COMPANY
P. O. BOX 1888 • TULSA, OKLAHOMA
HUDSON-RUSH COMPANY—753 Gladstone Blvd., Shreveport, La.
130 Casa Linda Plaza, Dallas 18, Texas
PROCESS INSTRUMENTS & EQUIP. CO. - North Bldg., Charleston, W.Va.

ALLIS-CHALMERS

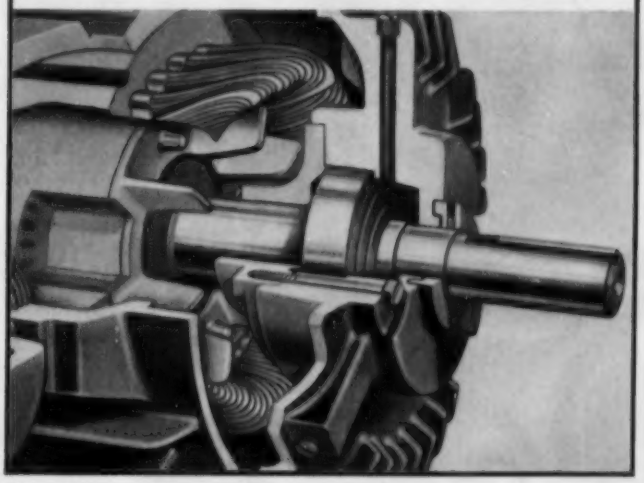
Underwriters' Laboratories, Inc. INSPECTED ELECTRIC MOTOR FOR HAZARDOUS LOCATION CLASS I GROUP D ANY SOIL

MOTORS

This Bearing, fully enclosed and protected, yet easy to grease when desired ...gives more value for your motor dollar

The bearing cap is held tightly in place against the inner face of the bearing enclosure. This cap, with its close running clearances, keeps grease from the interior of the motor . . . retains an ample supply within the bearing enclosure.

At the outer side of the bearing, double labyrinth seals keep grease in, also keep dirt out. What's more, large grease reservoirs act as additional dirt traps.



Lubricate without dismantling motor. Pipe-tapped holes in the bearing housings at two points provide both means for inserting new grease and a means of flushing out old grease.

Look for the extra bolts on the end housing... the sign of greater value. Ask your Allis-Chalmers representative or Authorized Distributor to show you a cutaway section of this maintenance-cutting design. Or write Allis-Chalmers, Milwaukee 1, Wisconsin, for Bulletin 51B7286.

ALLIS-CHALMERS AC ALLIS-CHALMERS

A-4576

Superior Railway Products Corp. uses Multigrip to *safe-tread* their loading equipment

For safety's sake this "traveling" hydraulic loading platform—in use at The Kirby Storage and Transfer Co., Pittsburgh—is made of Multigrip. The platform travels out to where the truck can be easily loaded, and then travels back.

This portable, adjustable loading ramp is made of Multigrip too. The front leaf only need be raised as one truck leaves and another backs up to the platform.

TO BE SURE of maximum traction at all times for busy feet and wheels, Superior Railway Products Corp., of Pittsburgh, have safe-treaded the loading equipment they manufacture (see cuts) with USS Multigrip Floor Plate. Multigrip's sure-grip, never-fail risers prevent accidents from slips and skids (even when it is wet) wherever it is used.

You can install Multigrip with a minimum of trouble and expense for it is easy to cut and bend as necessary; it is available in large sections, reducing cutting waste; and its pattern is symmetrical, making it easy to match the sections. Multigrip lasts for years—it doesn't crack, chip, rot or splinter as other flooring materials do—requires practically no maintenance and is easy to keep clean.

Benefiting from the experience of others, it will pay you to make a careful check of all the potential danger spots in *your* plant or shop. Don't overlook: aisles around machinery, all ramps and stairs, runways and catwalks, warehouse floor and loading areas, and the entire plant floor area too. Multigrip protects your floors as well as your workers . . . all heavy traffic areas should be protected with heavy duty Multigrip for longer life. Can be used as a covering or structurally.

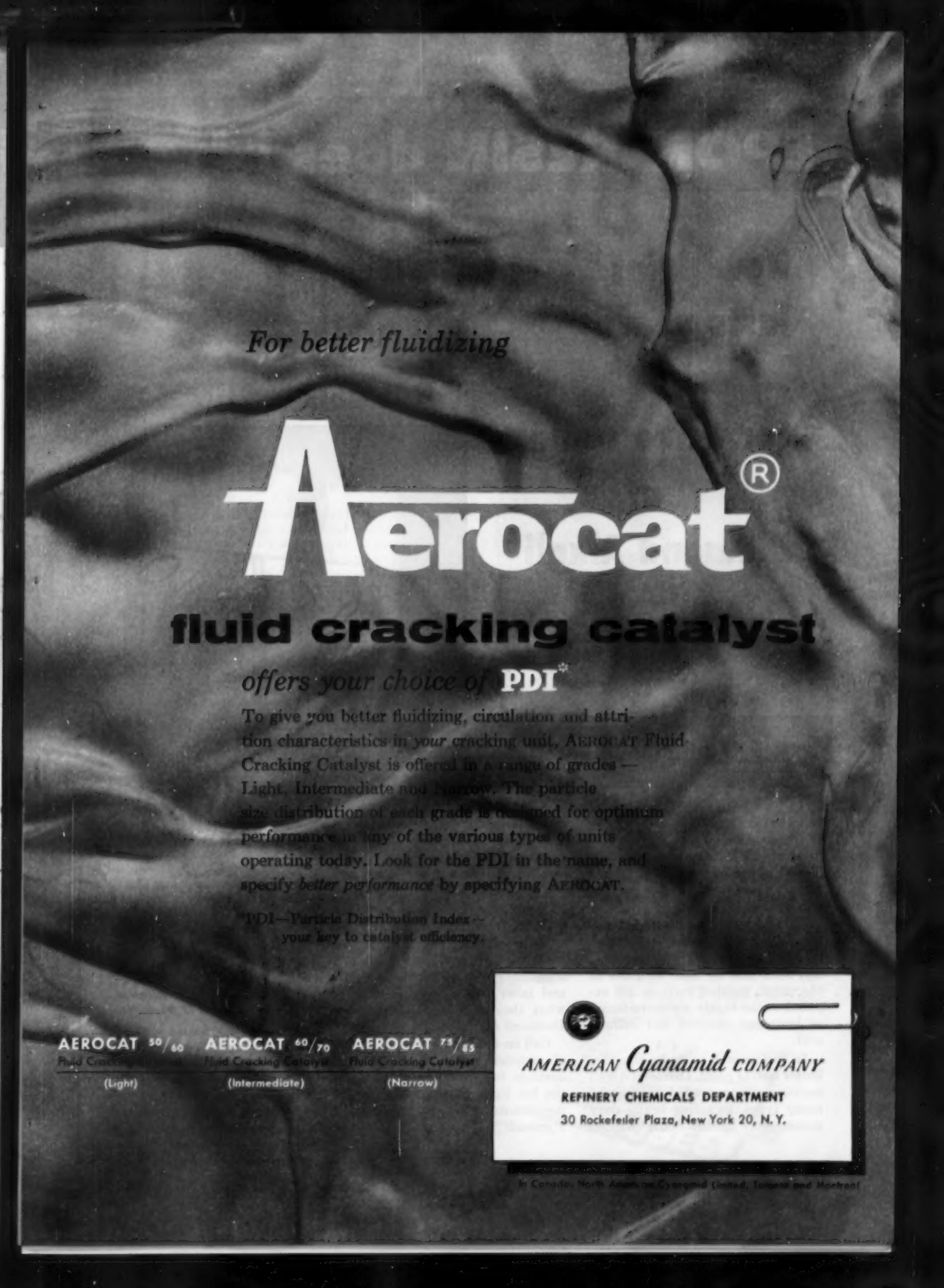
SEE The United States Steel Hour. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

UNITED STATES STEEL CORPORATION, PITTSBURGH
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, CHICAGO
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS multigrip FLOOR PLATE

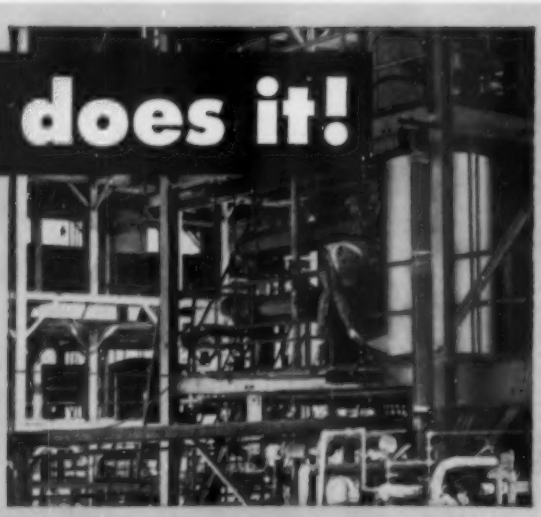
Sold by leading distributors from coast to coast S-257

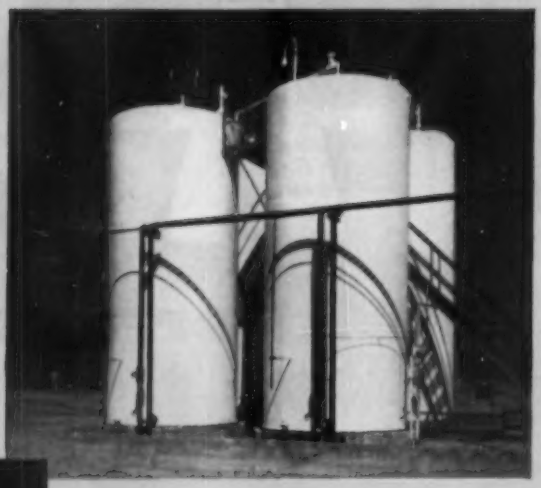
UNITED STATES STEEL


For better fluidizing
Aerocat®
fluid cracking catalyst
offers your choice of PDI*
To give you better fluidizing, circulation and attrition characteristics in your cracking unit, AEROCAT Fluid Cracking Catalyst is offered in a range of grades — Light, Intermediate and Narrow. The particle size distribution of each grade is designed for optimum performance in any of the various types of units operating today. Look for the PDI in the name, and specify better performance by specifying AEROCAT.
*PDI—Particle Distribution Index — your key to catalyst efficiency.
AEROCAT 50/60 Fluid Cracking Catalyst (Light)
AEROCAT 60/70 Fluid Cracking Catalyst (Intermediate)
AEROCAT 75/85 Fluid Cracking Catalyst (Narrow)
AMERICAN Cyanamid COMPANY
REFINERY CHEMICALS DEPARTMENT
30 Rockefeller Plaza, New York 20, N. Y.
In Canada: North American Cyanamid Limited, Toronto and Montreal

EPON® RESIN does it!

New paint lasts years ...resists corrosive spillage at Diamond Alkali plant





HERE'S HOW...

PAINT LEADS a hard life at the Diamond Alkali Company agricultural chemicals plant in Houston, Texas . . . and no ordinary paint can survive there for long!

A few reasons for paint failure: Processing vessels and storage tanks are subjected to spillage of chlorinated hydrocarbons and benzene, and some also to heat. In parts of the plant, painted surfaces are exposed to the highly corrosive fumes of hydrogen chloride and sulfuric acid.

In their search to find a tougher, longer lasting paint, Diamond Alkali maintenance men tried coatings of many types, including heavy duty maintenance finishes. Some "washed off" immediately; some lasted 6 to 8 months. Finally, Epon resin coatings based on the XA-200 formulation were tried — and found outstandingly successful.

The Epon cold-cured paint, applied by spraying throughout the entire plant, has been in service for *more than two years with no failure.* Painting costs — for both material and labor—are a mere fraction of what they formerly were, reports Diamond Alkali.

Call on our sales offices for names of suppliers who sell Epon resin coatings for your needs. Write for the full Epon coatings story in the new brochure, *"Planning to Paint a Pyramid?"*

SHELL CHEMICAL CORPORATION

Chemical Partner of Industry and Agriculture

380 Madison Avenue
New York 17, New York

Atlanta • Boston • Chicago
Cleveland • Detroit • Houston
Los Angeles • Newark • New York
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Chemical Division, Shell Oil Company of Canada, Limited
Toronto • Montreal • Vancouver

Meet the Tubes that Meet Your Needs

B&W Seamless and Welded Carbon, Alloy and Stainless Tubing for Condensers and Heat Exchangers

CARBON STEEL

This grade is used where service conditions are mild, that is, where the temperatures involved are relatively low and corrosive attack is not anticipated.

LOW CHROMIUM STEELS

The addition of chromium and molybdenum give these alloys good strength at elevated temperatures and improved resistance to oxidation as well as resistance to deterioration in services involving some hot corrosive gases.

INTERMEDIATE CHROMIUM STEELS

These grades have applications similar to those of the low chromium group except the additional alloying elements improve their characteristics and permit higher operating temperatures. They are particularly adapted to the handling of oils or hydrocarbon fluids containing sulphur compounds.

NICKEL STEELS

These steels are particularly suited for handling neutral salt solutions such as sodium and potassium nitrate or sulphate. They have found service in the black liquor evaporators of soda and kraft paper mills. Another field of application has been in sub-zero temperature service where high impact resistance is also a necessity.

STAINLESS STEELS

These steels are for specialized application where service conditions are extreme, that is, where corrosive environments or high temperatures are problems. The stainless steels have wide usage in the chemical industries, petroleum refinery, paper making, drug preparation, food processing and dairy and beverage industries.

For sound assistance in meeting your specific tubing requirements, write for Bulletin TB-329A or, better yet, get in touch with Mr. Tubes, your link to B&W. He represents B&W's headquarters technical staff and strategically located district offices, and B&W's nationwide network of fine tubing distributors.

THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION
Beaver Falls, Pa. and Milwaukee, Wis.: Seamless Tubing, Welded Stainless Steel Tubing
Alliance, Ohio: Welded Carbon Steel Tubing
Milwaukee, Wis.: Seamless Welding Fittings

B&W SEAMLESS and WELDED TUBES

TA-4044(CWP)

For more data on advertised products, use Readers' Service Cards, last page.

WE'VE CRACKED THE OCTANE BARRIER

Rexfo

*Pioneered by the Developers of Platforming —
The Industry's First Platinum Catalyst Reforming Process.

r m i n g*

A completely new standard of octane quality is now available to all refiners thru REXFORMING† — a development that employs an entirely new concept in producing gasolines with clear octanes in excess of 100. And REXFORMING does this economically and continuously without limitations as to type of crude processed in the refinery.

Another important fact is that REXFORMING will make gasolines of any intermediate octane that the refiner may require.

REXFORMING is one more development pioneered by Universal — a significant milestone in the never-ending progress of petroleum refining technology.

Regardless of your present reforming operations, you'll ultimately need and want REXFORMING.

†Trademark

UNIVERSAL OIL PRODUCTS COMPANY

UOP

20 ALGONQUIN ROAD,
DES PLAINES, ILL., U. S. A.
Laboratories: RIVERSIDE, ILLINOIS

Universal Service Protects Your Investment

reduce slag

stay on stream at top capacity months longer with the

Ljungstrom® Air Preheater

HOW FAST IS "WRITE OFF"?

By cutting turnaround time alone, the Ljungstrom means major savings for you. When you take the other Ljungstrom advantages into account—up to 20% fuel saving . . . more economical furnace design, with no need for convection surfaces . . . burns many fuels you used to throw away . . . consistently higher through-put . . . higher product quality—you can see why a Ljungstrom is paid out in just a few months.

For more complete details on what the Ljungstrom Air Preheater can do for you . . . for an analysis of the heat recovery benefits attainable in fuel burning equipment—call or write The Air Preheater Corporation.

Wherever You Burn Fuel, You Need Ljungstrom

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.

Slag—primary cause of reduced capacity—can be substantially reduced by the Ljungstrom Air Preheater.

That's because preheated air mixes more thoroughly with fuel. The result is better combustion . . . and less slag-forming material present in the furnace. Oil tubes stay cleaner . . . stills stay on stream at top capacity for months longer. As an example, one pipe still in an eastern refinery dropped from 16,000 barrels a day to 12,000 because of slag. Now, with a Ljungstrom and modern high-temperature burners, the still operates continuously at 18,000/20,000 barrels.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

GENERAL REFRACTORIES

FILET MIGNON—a la BRICK Sizzling, savory, juicy—dripping with butter—dashed with Worcestershire—and all of it brought to your table because of brick—refractory brick.

Refractories that contain the flames of industry. That produce the steel for your stove, your cabinets, your cooking utensils . . . provide the heat for the oven, the cold for the refrigerator . . . make rails, cars and engines which bring your steak to town; the wheels, body and motor of the truck which delivered it to the butcher. The platter on which it is served. The knife to cut it. The fork to eat it. The lights for the table. All—born of refractories.

Practically everything made or moved requires refractories. Refractories of almost infinite variety, prescribed and tailored for each special task.

Developing them, producing them, applying research to their improvement, drawing on resources all over the world, is the complete refractories service that we provide to industry, everywhere.

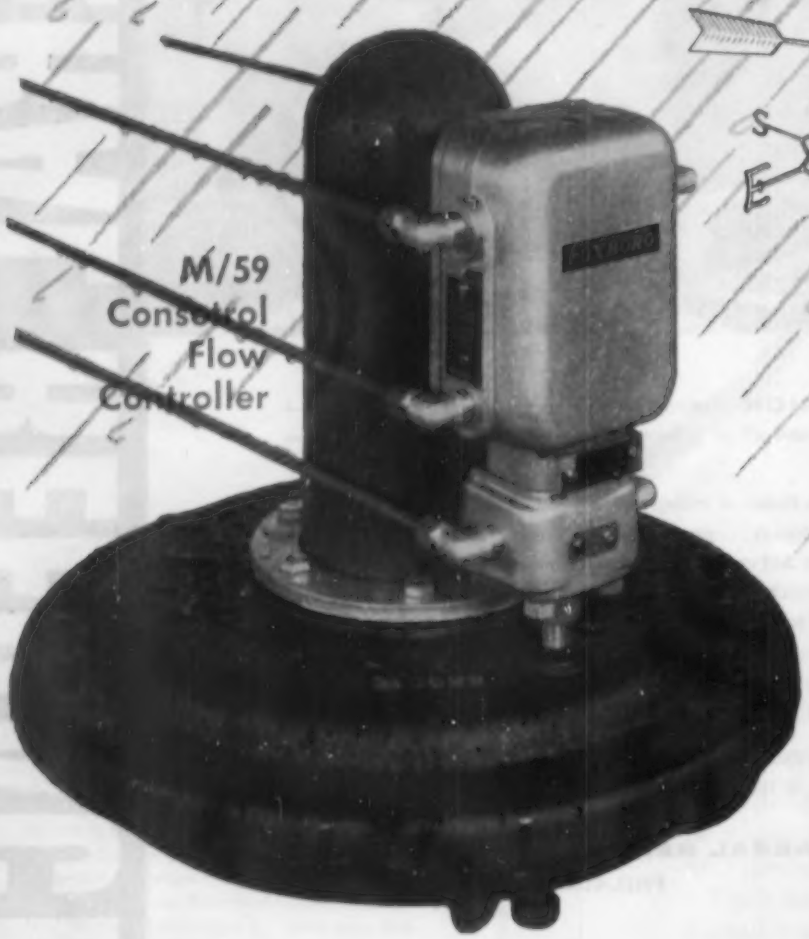
GENERAL REFRACTORIES COMPANY
PHILADELPHIA 2

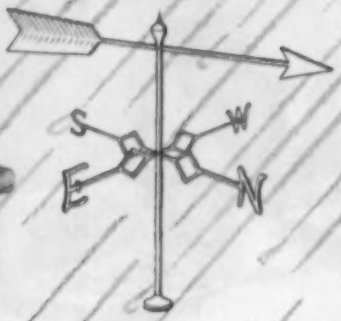
LITECAST-50—A hydraulic setting light weight castable having a density of approximately 50 lbs. per cu. ft. Available in regular mix and pneumatic gun mix.

HIGH-STRENGTH BRIK-CAST—A hydraulic setting clay base castable having exceptionally high strength. Available in regular, pneumatic gun mix and trowel mix.

GREFCO CASTABLES are manufactured at 4 strategically located plants in Pennsylvania, Missouri, Texas, and California.

This Controller
requires no more attention than a weathervane!





Like a weathervane, the Foxboro M/59 Consotrol Controller can be installed completely exposed to the elements . . . and forgotten about! Unsurpassed in performance by any other flow controller, the M/59 is *completely indifferent to weather conditions.*

This rugged Flow Controller mounts directly on the air connection of the valve . . . at a fraction of usual installation cost. Its case is tightly gasketed, continuously purged, completely weatherproof, highly resistant to dust, fumes, and vibration. There's nothing to align, nothing to wear out. A flexure-strip fulcrum eliminates the friction and wear of conventional pivots . . . eliminates "conventional" maintenance.

In operation, the M/59 fully utilizes the speed and sensitivity of the Foxboro d/p Cell Flow Transmitter . . . does away with transmission lag . . . gives fastest recovery from process upsets. For the *complete* story, write today for Bulletin 470.

"Live-Balance" Control on any fluid with any size valve motor.

Lowest first cost. Lowest installed cost.

Lowest maintenance cost.

Unique Simplicity — exclusive design permits fixed, optimum proportioning and reset values for liquid flows. Adjustable reset optional for gas or steam flow.

THE FOXBORO COMPANY, 744 NEPONSET AVENUE, FOXBORO, MASS., U.S.A.

FOXBORO
REG. U. S. PAT. OFF.

FLUID FLOW CONTROLLERS

FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

Our 125 "dry holes"

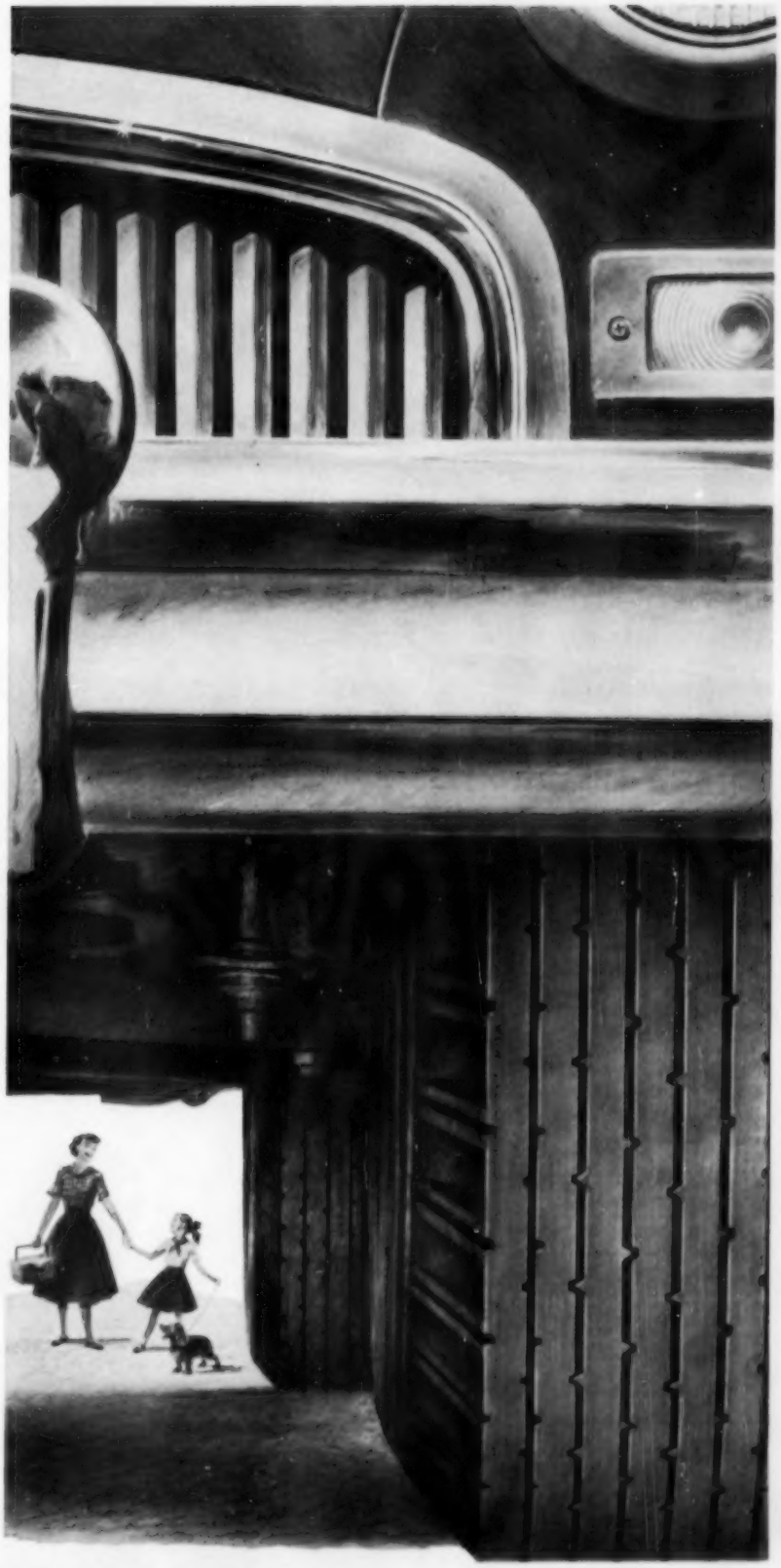
last year helped keep you on wheels

If you're anything like the average motorist, you'll need about 690 gallons of gasoline to take you where you want to drive this year. And that's just a beginning. Keeping you on wheels and supplying you with the thousand and one "oil-born" products so vital to modern living requires 2 gallons of petroleum a day for every man, woman and child in the U.S. — an increase of 58% since 1941.

Helping to keep this oil flowing to you is Standard Oil Company of California's biggest, most expensive, least predictable job. In fact, we plan to invest $200 million during 1955 alone in exploring for new oil fields and developing existing ones, to help replace the petroleum you'll use.

Some 700 times during the year, Standard drillers will start bits spinning. As much as 16,000 feet of pipe may follow the bit before oil is found or the well is abandoned. Either way it's a costly hole: drilling an oil well may run anywhere from $125,000 to over $1 million. And every one is a risk—only 1 out of every 9 wells drilled in the United States in a promising but unproven area ever turns out to be an oil producer.

Yet new sources of oil must be found to keep our nation's abundant supplies from dwindling. Risking "dry holes" is the only way to find them. So the 125 "dry holes" we drilled last year are good evidence of the job Standard does to help keep you on wheels.



STANDARD OIL COMPANY OF CALIFORNIA *plans ahead to serve you better*

For more data on advertised products, use Readers' Service Cards, last page.

Depend on LADISH

- Carbon Steels
- Carbon-Molybdenum Steels
- Chromium-Molybdenum Steels
- Nickel Steels
- Chromium-Nickel Steels
- Chromium-Silicon-Molybdenum
- Wrought Iron
- Chromium Type Stainless
- Chromium-Nickel Stainless
- Molybdenum Type Stainless
- Wrought Aluminum
- Aluminum-Copper Alloys

BUTT WELDING FITTINGS

½ inch through 42 inches . . .

FORGED CORROSION RESISTANT—LIGHT WEIGHT and A.S.A. FLANGES

½ inch through 24 inches . . .

FORGED SCREWED OR SOCKET WELDING FITTINGS and UNIONS

⅛ inch through 4 inches . . .

LARGE DIAMETER AND T.E.M.A.* STANDARD FLANGES up to 20 feet O.D.

*Tubular Exchanger Manufacturers Association

LONG WELDING NECKS up to 24 inches, 150 lb. through 2500 lb.

Complete Service . . .

BUTT WELDING FITTINGS

Schedules 5S, 10S, 40S, 80S, and other Schedules and wall thickness.

FORGED CORROSION RESISTANT—LIGHT WEIGHT and A.S.A. FLANGES

150 lb. through 2500 lb. pressure ratings.

FORGED SCREWED OR SOCKET WELDING FITTINGS and UNIONS

150 lb. Corrosion Resistant and 2000 lb. through 6000 lb. ratings.

FOR FITTINGS FROM ANY FORGEABLE MATERIAL TO MEET YOUR SERVICE REQUIREMENTS

You get prompt, efficient service when you specify and order from the complete Ladish Controlled Quality line. Fittings *in any forgeable material* in virtually every type, size, wall thickness or pressure rating . . . are produced to one uncompromising Controlled Quality standard . . . and identified with heat code symbols pioneered by Ladish as verification of metallurgical integrity resulting from exhaustive tests made in the Ladish metallurgical laboratories.

For *complete service* on your fittings requirements, depend on the Ladish line and the services of your Authorized Ladish Distributor.

THE COMPLETE *Controlled Quality* FITTINGS LINE

LADISH CO.

CUDAHY, WISCONSIN

MILWAUKEE SUBURB

District Offices: New York • Buffalo • Pittsburgh • Philadelphia • Cleveland
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L

TO MARK PROGRESS

- Aluminum-Manganese Alloys
- Deoxidized Copper
- Hastelloy
- Titanium
- Forging Brass
- Everdur Bronze
- Silicon Bronze
- Manganese Bronze
- Wrought Nickel
- Nickel-Copper Alloys
- Inconel
- Monel

11 ALL-IMPORTANT FACTORS WHICH DETERMINE THE VALUE AND EFFICIENCY OF PROCESSING FURNACES

✔**UNIFORM HEAT DISTRIBUTION**
MAXIMUM FUEL EFFICIENCY
PLENUM CHAMBERS FOR HAZARDOUS AREAS
SIMPLICITY OF DESIGN AND CONSTRUCTION
EXCESS DRAFT FOR HIGH OVERLOAD
EXPLOSION RESISTANT
MINIMUM GROUND SPACE
SHORT LENGTH OF LIQUID TRAVEL
ZERO AIR LEAKAGE
LOW PRESSURE DROP
LOW MAINTENANCE

✔**UNIFORM HEAT DISTRIBUTION** the most desirable heater characteristic is created in an Iso-Flow furnace by:

1. Individual burners are so spaced in relationship to the heating elements that they create a symmetrical flame pattern with relation to the tubes;

2. The metal cone at the top of the combustion chamber re-radiates to the tubes, also diverts combustion gases progressively closer to the tubes to give a uniform heat intensity at the upper portion of the combustion chamber;

3. The combustion gases, at the top of the heater, are diverted towards the walls where they recirculate from the top of the heater downward, behind and between the tubes, increasing the heat input to the rear of the heating elements by convection;

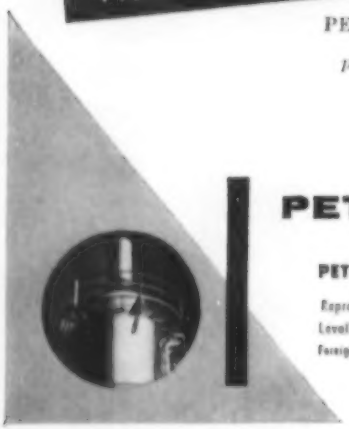
4. The recirculated gases reduce the heat intensity at the bottom of the furnace so that the heat input is the same, top and bottom.

These factors provide the completely uniform heat distribution required in heaters for the most efficient process operation.

In every case where these 11 all-important design characteristics were employed to compare one type of furnace design with another, PETROCHEM-ISOFLOW FURNACES *were proved most efficient by any comparison.*

Prove PETROCHEM-ISOFLOW FURNACES Most Efficient by Any Comparison

More than 1200 PETROCHEM-ISOFLOW FURNACES *are in operation throughout the world in the petroleum, chemical and allied industries . . . for all processes and for any duty, pressure, temperature and efficiency . . . and all Petrochem-Isoflow Furnaces are pre-eminently satisfactory.*



PETROCHEM-ISOFLOW FURNACES

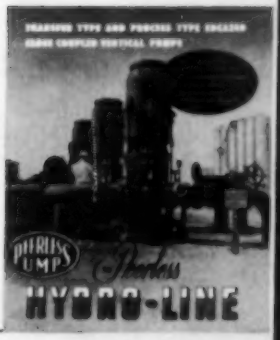
UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

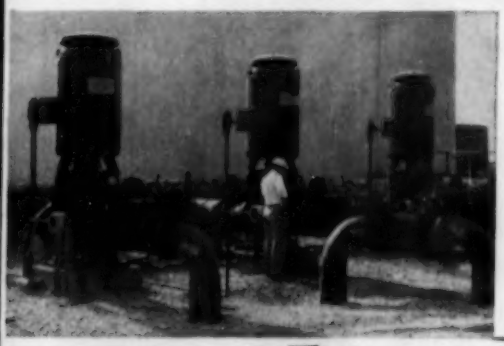
PETRO-CHEM DEVELOPMENT CO., INC. • 122 East 42nd St., New York 17, N. Y.

Representatives: Bethlehem Supply, Tulsa and Houston • Flagg, Brockett & Burgin, Boston • D. B. Foster, Pittsburgh • Faville-Levally, Chicago • Lester Oberholtz, Los Angeles • Gordon B. Hardin, Louisville • Turbex, Philadelphia (Narberth, Pa.)
Foreign Licensees: England – BIRWELCO, LTD., Birmingham 6 • France – HEURTEY & CIE, Paris • Germany – DR. C. OTTO & COMP., Bochum

new VERTICAL Versatility

THE TREND IS TO VERTICAL PUMPS FOR TRANSFERRING MANY TYPES OF PROCESS LIQUIDS





HERE ARE TWO PEERLESS PUMPS THAT MEET THE NEED WITH ECONOMY, EFFICIENCY AND DEPENDABILITY—The two new Peerless pump bulletins shown at the left above describe the two types of modern Peerless process liquid pumps shown installed at the right.

Write for your copies. They describe and illustrate the pluses of Peerless vertical process pump design, construction and operation.

Bulletin No. B-1700 describes Peerless Hydro-Line can type pumps; Bulletin No. B-505 describes Peerless industrial service pumps. Both types are applied to the successful transfer of processing liquids. *Use the coupon below.*

PEERLESS PUMPS

fmc

PEERLESS PUMP DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION
Factories: Los Angeles 31, Calif. and Indianapolis 8, Ind.
Offices: New York; Atlanta; Chicago; St. Louis; Indianapolis; Phoenix; Fresno; Los Angeles; Plainview and Lubbock, Texas; Albuquerque, New Mexico.
Distributors in Principal Cities; Consult your Telephone Directory.

PEERLESS PUMP DIVISION
Food Machinery and Chemical Corporation
301 West Avenue 26, Los Angeles 31, California

Please send bulletins checked below:

☐ PEERLESS HYDRO-LINE CAN TYPE PUMPS B-1700

☐ PEERLESS VERTICAL INDUSTRIAL SERVICE PUMPS B-505

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

Pet. Ref.

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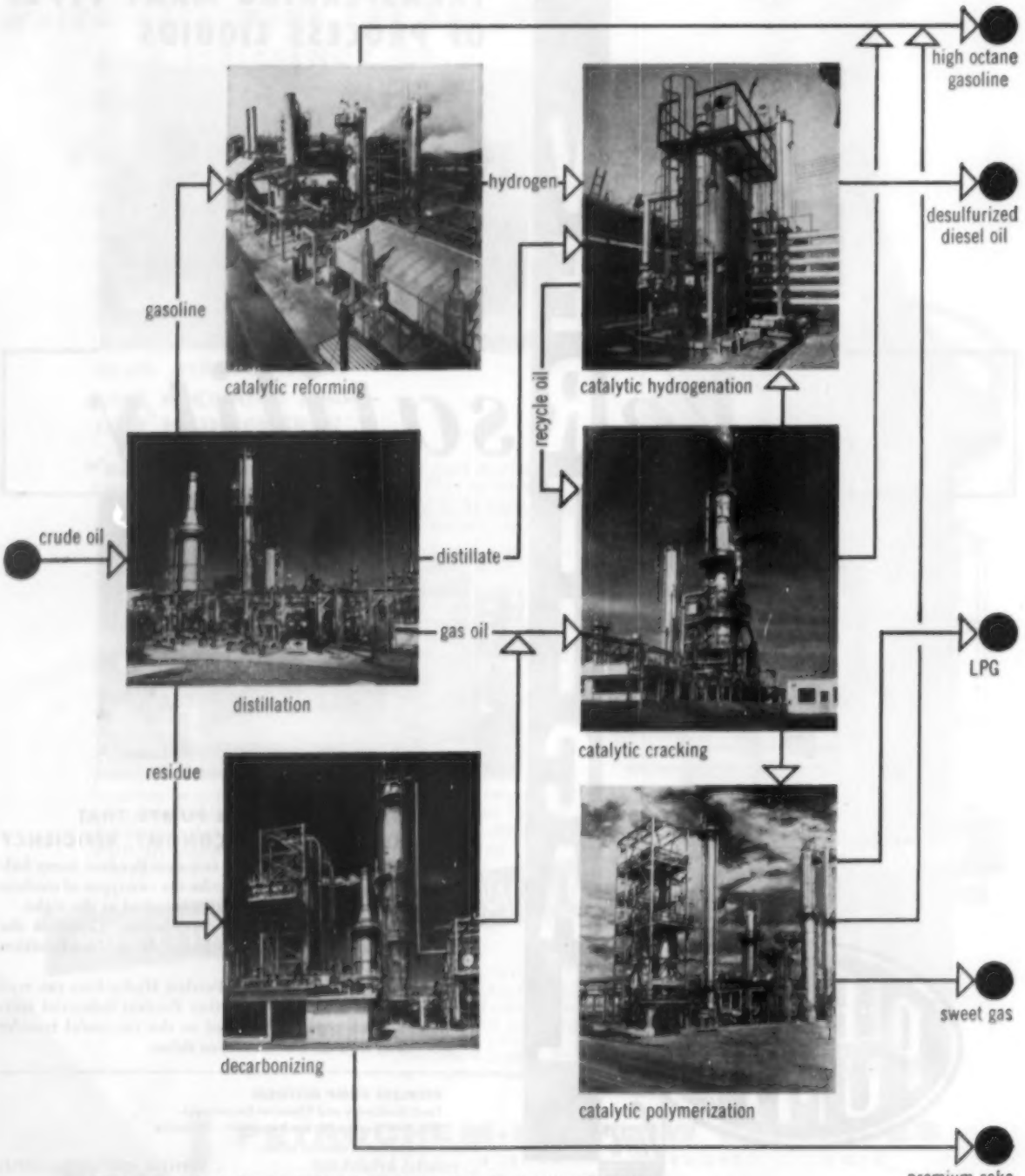
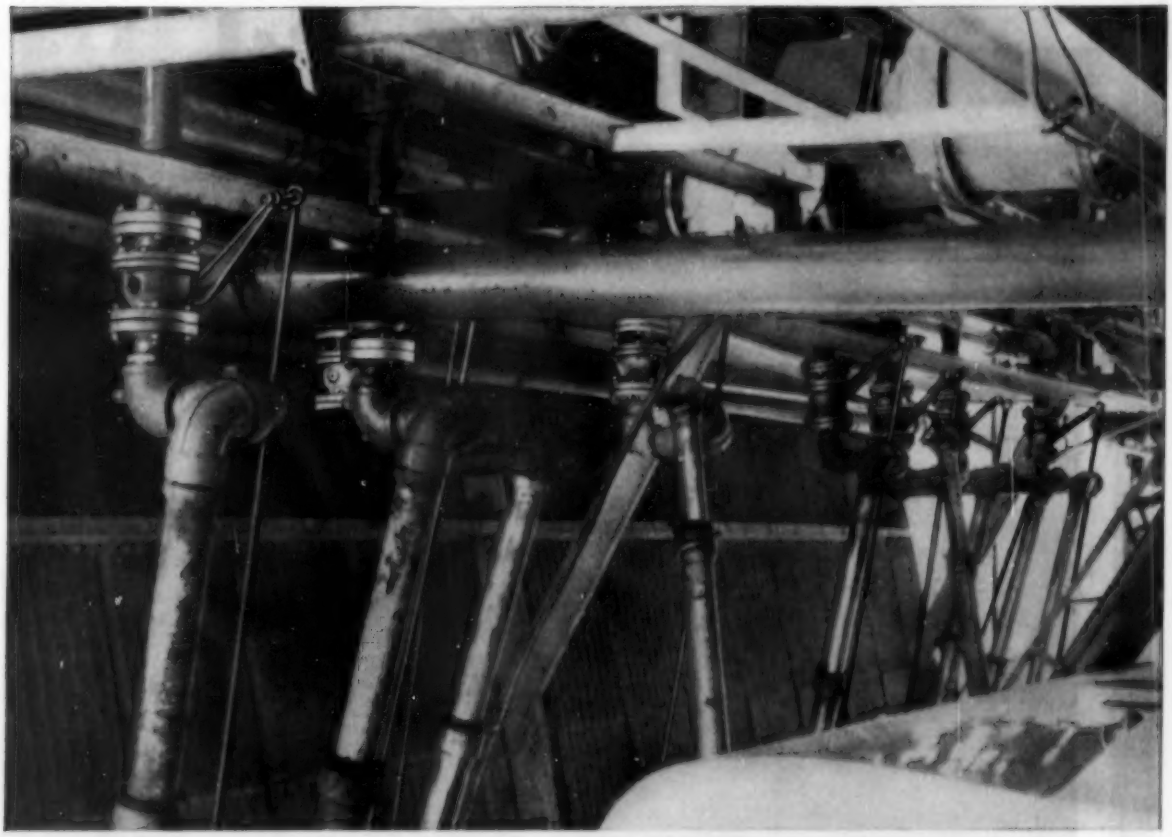
BLAW-KNOX

Catalytic Processing for Maximum Profits



These are typical of units designed, erected and modernized by Blaw-Knox.
Your inquiries for a single unit or a complete refinery will be handled promptly.

BLAW-KNOX COMPANY Chemical Plants Division
Tulsa 1, Oklahoma
Pittsburgh 22, Pa./Chicago 1, Ill.



Busiest loading rack in the Midwest relies on Rockwood Ball Valves

Day in, day out, twenty-four hours a day, the fuel loading rack above fills tank trucks — in record time.

Eight Rockwood Ball Valves perform this grueling operation, opening and closing in trigger time — permitting a full, round flow of fuel — and preventing dangerous oil sludge on the loading pavement by remaining absolutely leak-proof.

What makes Rockwood Ball Valves so outstanding? These four exclusive features assure trouble-free efficiency:

Full Round Flow — no change in shape or volume of fluid stream — no turbulence — no minimum loss.

Quick Opening and Closing — only a quarter turn needed, even under full pressure.

Longer Wear-Resistance — chrome-plated bronze ball withstands abrasion, pitting and scratching.

Leakproof Seal — pressure of fluid automatically positions ball against seat to form tight seal.

If you are not now using Rockwood Ball Valves, send coupon today for complete information. Valves come in all pipe sizes. Tested and listed by Underwriters' Laboratories, Inc.

ROCKWOOD BALL VALVES

FULL, ROUND FLOW

ROCKWOOD SPRINKLER COMPANY
564 Harlow Street
Worcester 5, Mass.

Send me illustrated folder V-4 on Rockwood Full-Flow Ball Valves.

Name .....

Title .....

Company .....

City .....

Zone ..... State .....

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A.O.Smith for

VESSELS

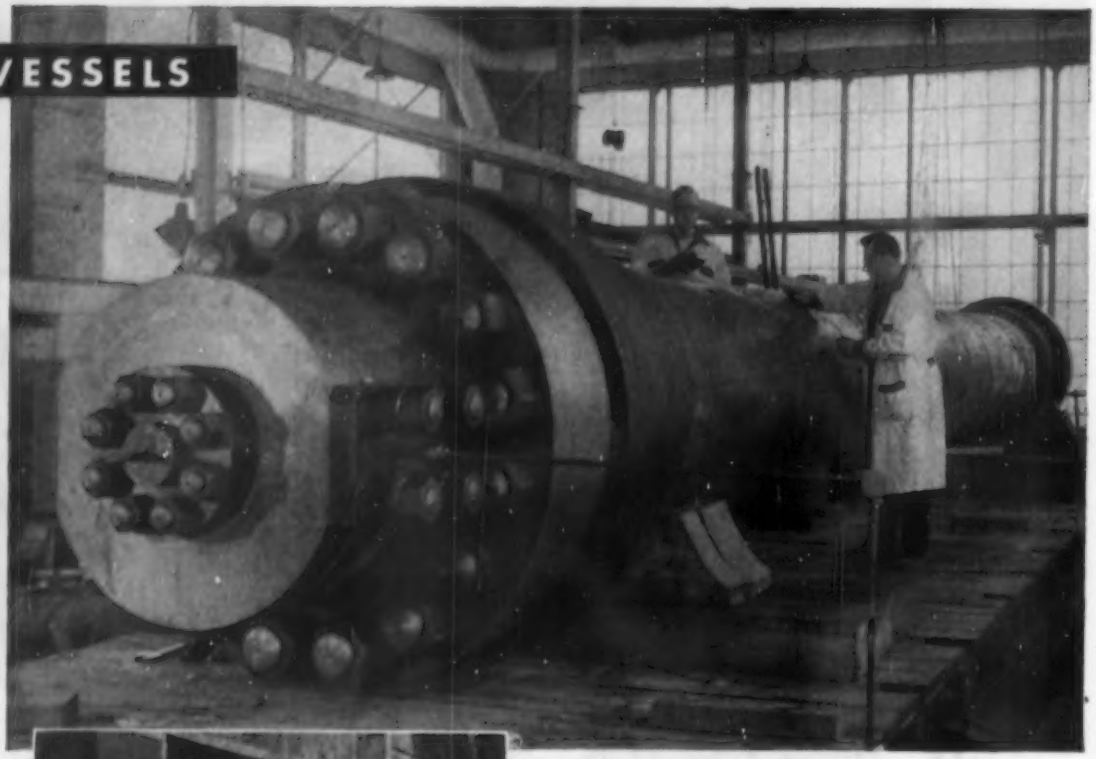


Photo shows MULTI-LAYER ammonia super-pressure converter on test at A. O. Smith. Inside vessel diameter is 25¾ in. . . . length from one flange face to the other is 44 ft. 3 in. . . . weight 238,000 lbs. Vessel is designed for operating pressures of 12,500 psi at a temperature of 450° F.

A. O. Smith technician checks gauges on converter undergoing pressure tests. The giant vessel is being tested out at 18,750 psi.

If your process involves high

DESIGN

THE ANSWER TO THE HIGHER PRESSURES WITH SAFETY

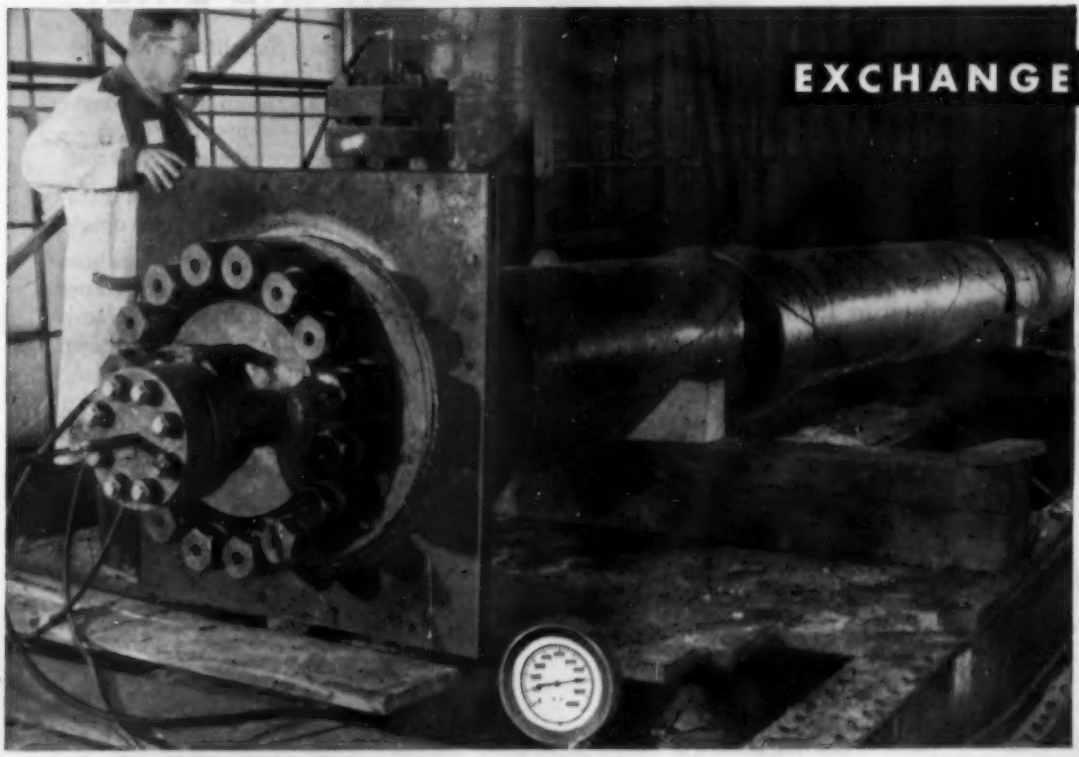
A. O. SMITH MULTI-LAYER construction offers significant advantages to the men who operate plants or design equipment for the processing industries. Today . . . right now . . . they can design for the higher pressures that will be required in the future.

In MULTI-LAYER construction, successive concentric layers of relatively thin steel plate are wrapped and welded around a central pressure-tight cylinder. There's no limitation of size or weight . . . no restrictions imposed by ingot size or forming techniques. The variations are endless.

Positive safety under pressure, too! By testing to destruction full-scale vessels at pressures in excess of

For more data on advertised products, use Readers' Service Cards, last page.

Outstanding Advantages



Here's a Multi-LAYER recycle heat exchanger undergoing test pressure of 7,920 psi. Inside diameter is 17 in. . . . MULTI-LAYER wall thickness is 3⅜ in. . . . overall length 29 ft. 2 in. Weighing 31,200 lbs., this exchanger is designed for shell-side operating pressures of 5,280 psi.

pressures, high temperatures or corrosive materials,

WITH MULTI-LAYER

40,000 psi, A. O. Smith has proved that MULTI-LAYER vessels burst without fragmentation.

Pick the alloy lining required to fit your needs! MULTI-LAYER vessels can be fabricated with inner cylinder of lined or clad plate, alloy steel or non-ferrous materials. The outer layers of the vessel can then be fabricated of high strength steel to resist the pressure loads.

Let A. O. Smith engineering and research help you adapt MULTI-LAYER vessels and heat exchangers to your operation.

Write for free bulletins: "MULTI-LAYER Manufacturing and Assembling" . . . "MULTI-LAYER Engineering for Safety."

Through research A.O. Smith *. . . a better way*

A.O.Smith
CORPORATION

PROCESS EQUIPMENT DIVISION
International Division: Milwaukee 1, Wis.
MILWAUKEE • HOUSTON • LOS ANGELES

For glass-lined process equipment, contact GLASCOTE PRODUCTS, INC., Cleveland 17, Ohio — A new A. O. Smith Subsidiary

For more data on advertised products, use Readers' Service Cards, last page.

ONE MORE REASON TO CHOOSE PRITCHARD COOLING TOWERS:

EVERY MEMBER IS WORKING HARDER NOW— YOU SAVE ALL THE WAY DOWN THE LINE!

That's why the new Pritchard cooling tower framework design means savings to you. The new design utilizes materials to the fullest possible extent. As an example, each diagonal member is used in both tension and compression. Result . . . a stronger, more efficient structure.

What does this mean to you? It means that Pritchard towers now offer you the following new advantages:

- Elimination of excess framework members reduces material and freight costs.
- Installation is faster and easier. You save on field labor costs.
- Basin cost is far less. Simplified design requires anchoring only around the periphery of the tower. Inside the basin, it is no longer necessary to build post-supporting piers — post extensions can be provided at far less cost.
- A Pritchard tower is now even easier to maintain . . . there are fewer connections to check.

Pritchard tower framework has always been completely pre-fabricated on precision machines for perfect fit. Now, new Pritchard design adds new efficiency, new economy. One *more* reason to choose Pritchard cooling towers!

INDUSTRY'S PARTNER FOR PROGRESS

COOLING TOWERS
AIR COOLED HEAT EXCHANGERS
GAS & AIR TREATING EQUIPMENT

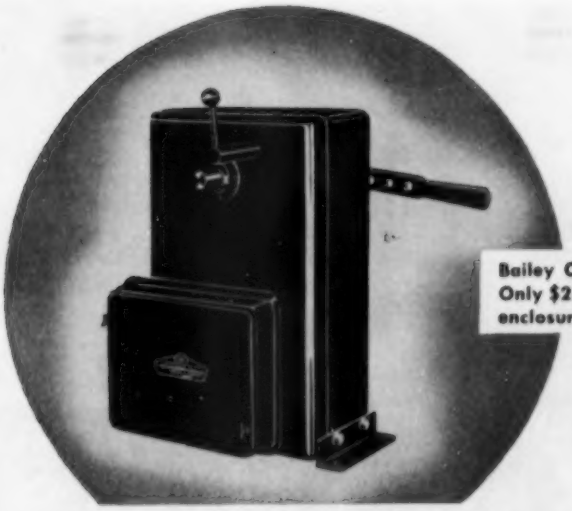
REPRESENTATIVES IN PRINCIPAL CITIES FROM COAST TO COAST

J.F. Pritchard & Co.
OF CALIFORNIA
A DIVISION OF J. F. PRITCHARD & CO.
Dept. 484, 4625 Roanoke Parkway, Kansas City 12, Mo.

new!

Get your complimentary copy of the new Pritchard brochure, "Answers to the 15 Questions About Pritchard Induced Draft Cooling Towers." Fascinating reading to anyone interested in learning more about cooling towers. Your copy awaits — write for it today on your company letterhead.

The raised ring around the circumference of one end of the Pritchard connector casting matches the ring groove in the framework member. Thus, stress or strain is never on the bolt, but is evenly distributed over the entire area of the ring.



Bailey Control Drive, Type AC44P Model 200. Only $210.00 F.O.B. Cleveland, complete with enclosure, positioning relay and hand operator.

Want Better Flow Characteristics from Your Regulating Devices?

This new, small, piston-operated Bailey Control Drive will improve the flow characteristics of butterfly valves, dampers, hydraulic couplings, feeders and similar regulating devices. Adjustment is simple; any desired relation between drive motion and pneumatic signal may be secured.

You can install this compact pneumatic drive power unit in any position on a column, pipe, or flat surface—and connect it to the regulating device with standard Bailey linkage, available from stock.

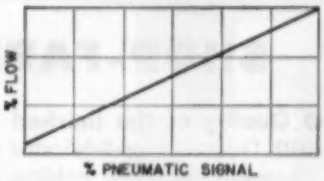
Speed (time required for full travel) is adjustable to suit your requirements. Bailey Control Drives operate on standard SAMA pneumatic signal ranges of 3 - 15 or 3 - 27 psig.

AVAILABLE FROM STOCK in 3 standard sizes

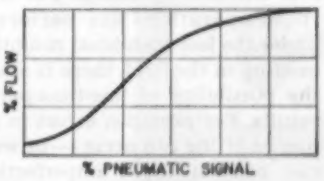
Type	Piston Dia. Inches	Piston Stroke Inches	Torque ft-lb	Max. Travel Degrees	Approx. Dimensions Inches
AC816	8	16	1500	90	13 x 27 x 51
AC68	6	8	400	90	13 x 19 x 34
AC44	4	4	75	75	10 x 11 x 19

P-28

The New Bailey Control Drive gives you THIS—



instead of THIS



BAILEY METER COMPANY

1043 IVANHOE ROAD

CLEVELAND 10, OHIO

Complete Controls for Process Plants

BAILEY METERS

Controls for

TEMPERATURE
PRESSURE
GAS ANALYSIS
FLOW LEVEL
RATIO

FOR MORE INFORMATION
FILL OUT AND MAIL

☐ I am interested in Bailey Control Drives. Mail me Spec. PB1-1.

☐ I am interested in Bailey Control Linkage. Mail me Spec. PB1-5.

Name_____

Title & Company_____

Street & Number_____

City & Zone_____ State_____

For more data on advertised products, use Readers' Service Cards, last page.

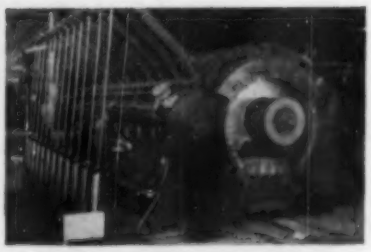
SHOP-FABRICATED PIPING BY GRINNELL

● **Quality of the finished job** With Grinnell shop-fabricated piping — cutting, fitting, welding, and assembly "on location" is reduced to an absolute minimum. That's the first Grinnell advantage. For when these operations are performed under the less-than-ideal conditions existing in the field, there is always the possibility of less-than-perfect results. For example, errors in cutting or fitting can occur — or welds can contain slight imperfections, which may be difficult to detect with equipment in the field.

In Grinnell shops, on the other hand, whole sections of complex piping are assembled — with every critical point checked with the latest equipment and by the most modern methods. When these sections arrive on site, they go up fast and *right*.

● **Final cost** With Grinnell shop-fabrication, there are no unforeseen costs. Included in the price (which is determined in advance) are such items of expense as: interpretive engineering, shop sketches and planning, procurement of materials, power services, expendable tools and supplies. There are no charges for waste material or spoilage.

Consider the quality of the finished job, and final cost. Then consult Grinnell on *your* next piping installation.



Pipe being heated to exact temperature required for proper bending.

Fabricated piping pieces entering stress-relieving furnace.

GRINNELL

WHENEVER PIPING IS INVOLVED

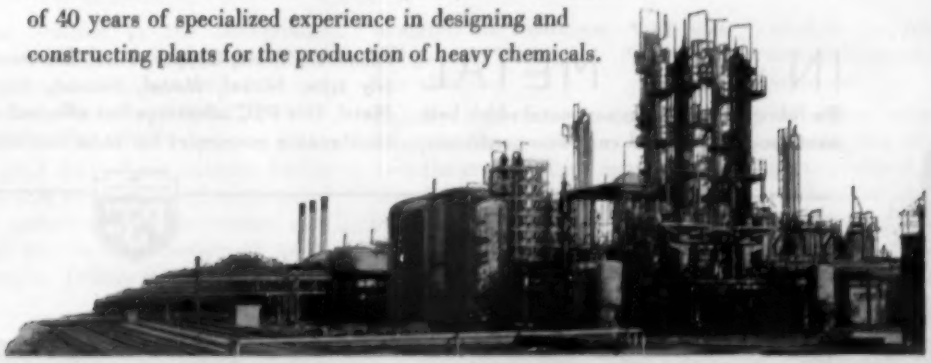
Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

CHEMICO

It's Your Move!

If you are planning to build a Chemical Process Plant—consult CHEMICO first • Chemico gives you the benefit of 40 years of specialized experience in designing and constructing plants for the production of heavy chemicals.



CHEMICAL CONSTRUCTION CORPORATION

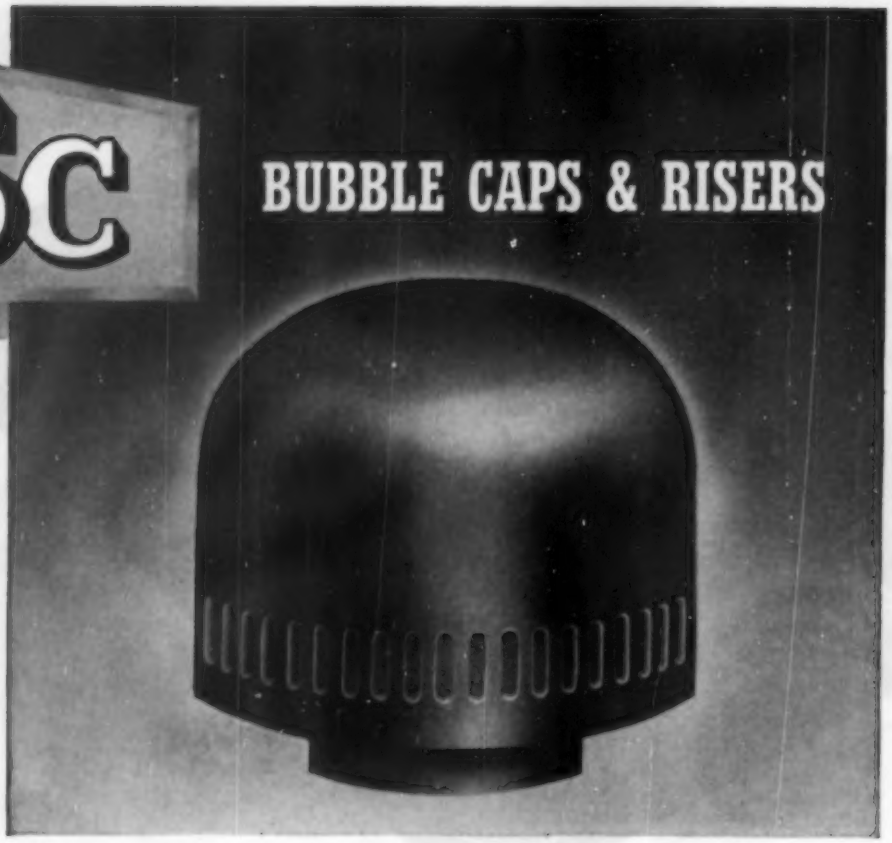
A UNIT OF AMERICAN CYANAMID COMPANY

525 WEST 43RD STREET, NEW YORK 36, NEW YORK

Cable Address: Chemiconst, New York • Technical Representatives: Cyanamid Products Ltd, London
South African Cyanamid (Pty) Ltd., Johannesburg

CHEMICO CHEMICAL CONSTRUCTION CORPORATION

PSC BUBBLE CAPS & RISERS



300 STANDARD STYLES *Without Die Cost*

With dies on hand for 300 standard styles of bubble caps and risers, PSC is saving many customers the cost of dies as well as design and delivery time. For all methods of tray assembly. Complete engineering details on all 300 styles in Catalog 54.

IN ANY METAL

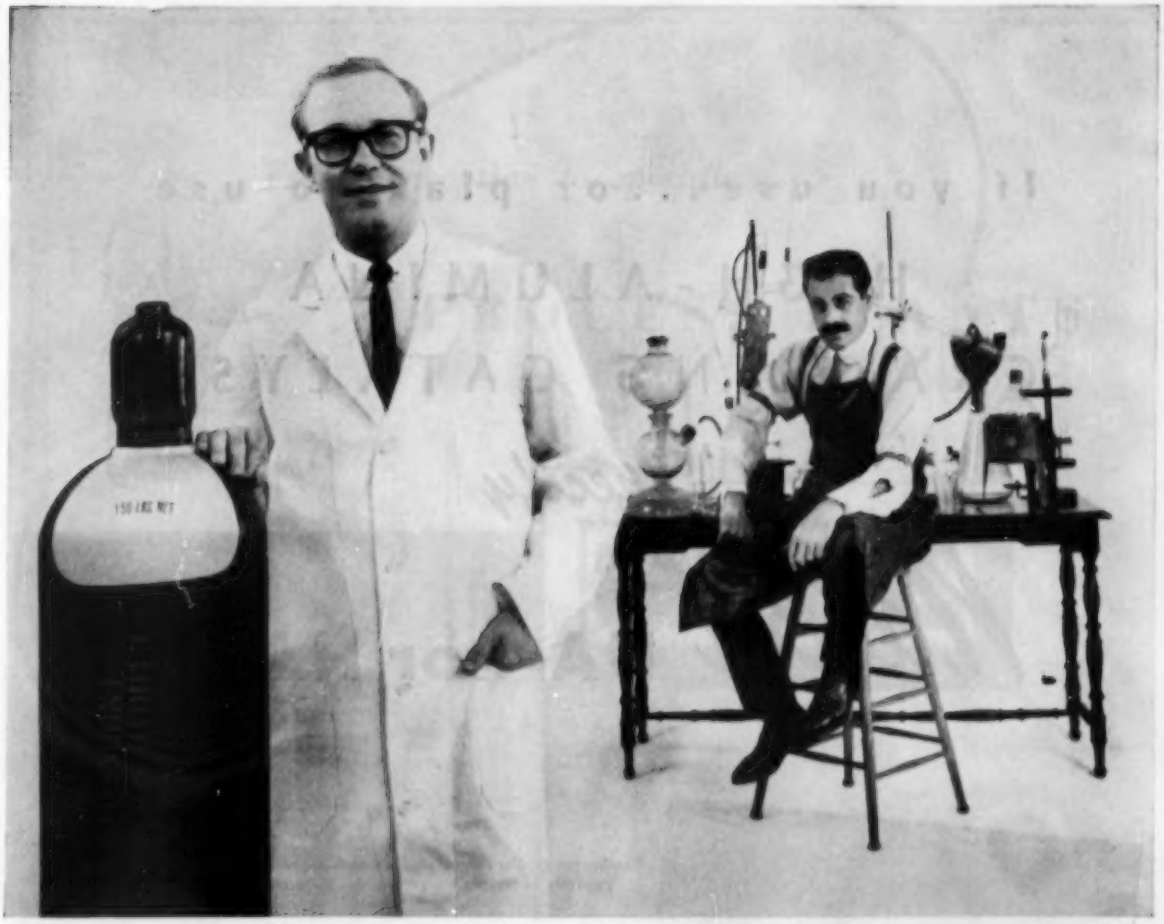
We fabricate caps from any metal which best meets your coking and corrosion conditions: Aluminum, Brass, Copper, Steel, Stainless of any type, Nickel, Monel, Inconel, Ampco Metal. This PSC advantage has effected real maintenance economies for some customers.

Send for Process Equipment Catalog 54

THE PRESSED STEEL COMPANY
of WILKES-BARRE, PENNSYLVANIA

Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

☆ ☆ ☆ OFFICES IN PRINCIPAL CITIES ☆ ☆ ☆



Experience and service make the difference when you buy Ansul Sulfur Dioxide

The chemist in the background (above) dates us—August of 1915 to be exact. This was the month and year we shipped our first cylinder of liquid sulfur dioxide.

A good deal of our energies during the past 40 years have been devoted to perfecting a quality-control system for the manufacture of sulfur dioxide. Today, it's no trick at all to supply our customers with a near 100 percent pure grade (99.9%) of this chemical.

Equally important, to our way of thinking (our customers' too), has been the growth of our service facilities. Over the years we have been privileged to work with a number of petroleum processors employing the Edeleanu Process. This experience in the field of sulfur dioxide aromatic extraction is available for your use.

When you order Ansul liquid sulfur dioxide, you can be sure of product purity, dependable delivery, plus application assistance. Write ANSUL CHEMICAL COMPANY, Dept. C-68, Industrial Chemicals Division, Marinette, Wisconsin.

ANSUL

For more data on advertised products, use Readers' Service Cards, last page.

If you use . . . or plan to use

HIGH-ALUMINA
CRACKING CATALYST

Specify

Nalcat **HA-1 or HA-2**

Continuous quality control and research progress are the products of Nalco Catalyst Division Laboratories.

Nalcat. Nalform

Production and Service to Match Petroleum Industry Progress

● If you are exploring the possibilities of high-alumina catalyst for your cracking operations, check on Nalcat HA-1 and HA-2 for research and production use. These high-alumina formulas are available in whatever quantities you require, promptly . . . as a part of the Nalco policy of *Service* to the Petroleum Industry.

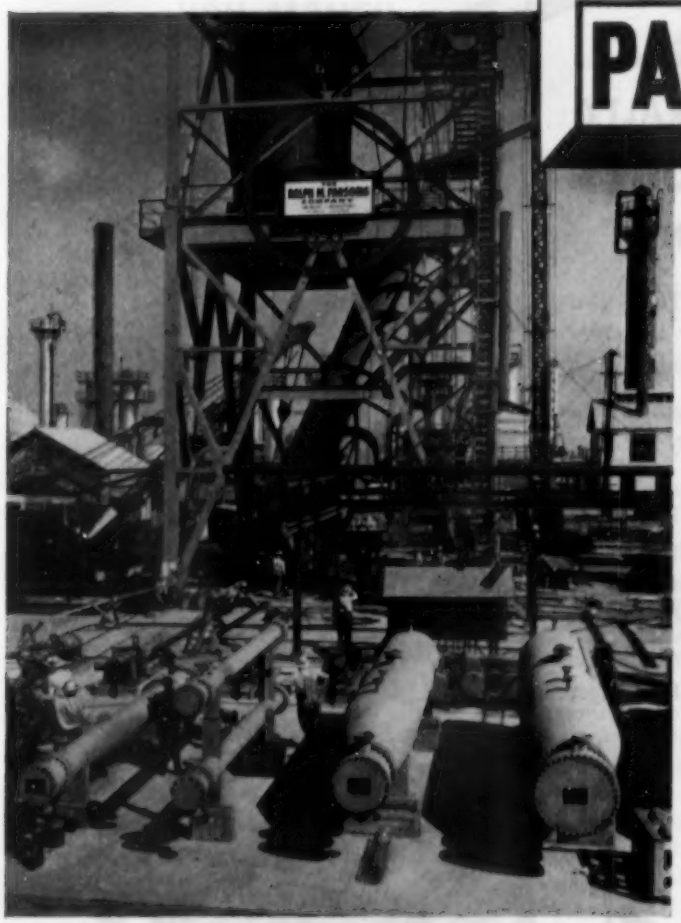
CATALYST DIVISION
NATIONAL ALUMINATE CORPORATION
4001 West 71st Street, Chicago 29, Illinois

From conception to operation . . .

PROCESS PLANTS

by

PARSONS



Design, engineering, procurement, construction — even operation of the facilities after completion — are regular functions performed by The Ralph M. Parsons Company . . . All these services are offered from a *single source* with a *single responsibility*.

THE RALPH M. PARSONS COMPANY

ENGINEERS • CONSTRUCTORS

617 South Olive Street • Los Angeles 14, California

NEW YORK • TULSA • WASHINGTON

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TOUGH!

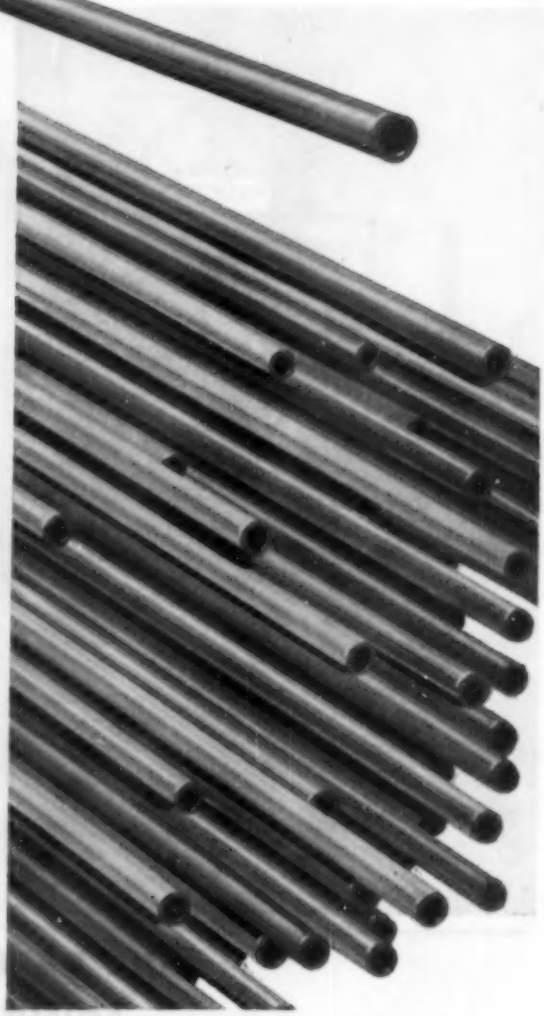
CHASE® ANTIMONIAL ADMIRALTY
HEAT EXCHANGER TUBES
RESIST DEZINCIFICATION!

Chase Antimonial Admiralty Heat Exchanger Tubes give *extra* years of service, because they contain the *right* amount of antimony needed to resist dezincification!

And antimony will *not* weaken tube strength! That's why Chase tubes *stay* sound through year after year of adverse conditions in the field.

Since 1935, Chase Antimonial Admiralty has added years of life to thousands of heat exchanger tube installations. When replacing heat exchanger tubes, or planning new installations, insist on Chase Antimonial Admiralty.

For more information on Chase Antimonial Admiralty, send for the free Chase Condenser and Heat Exchanger Tube Booklet.



Chase®

BRASS & COPPER CO.

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

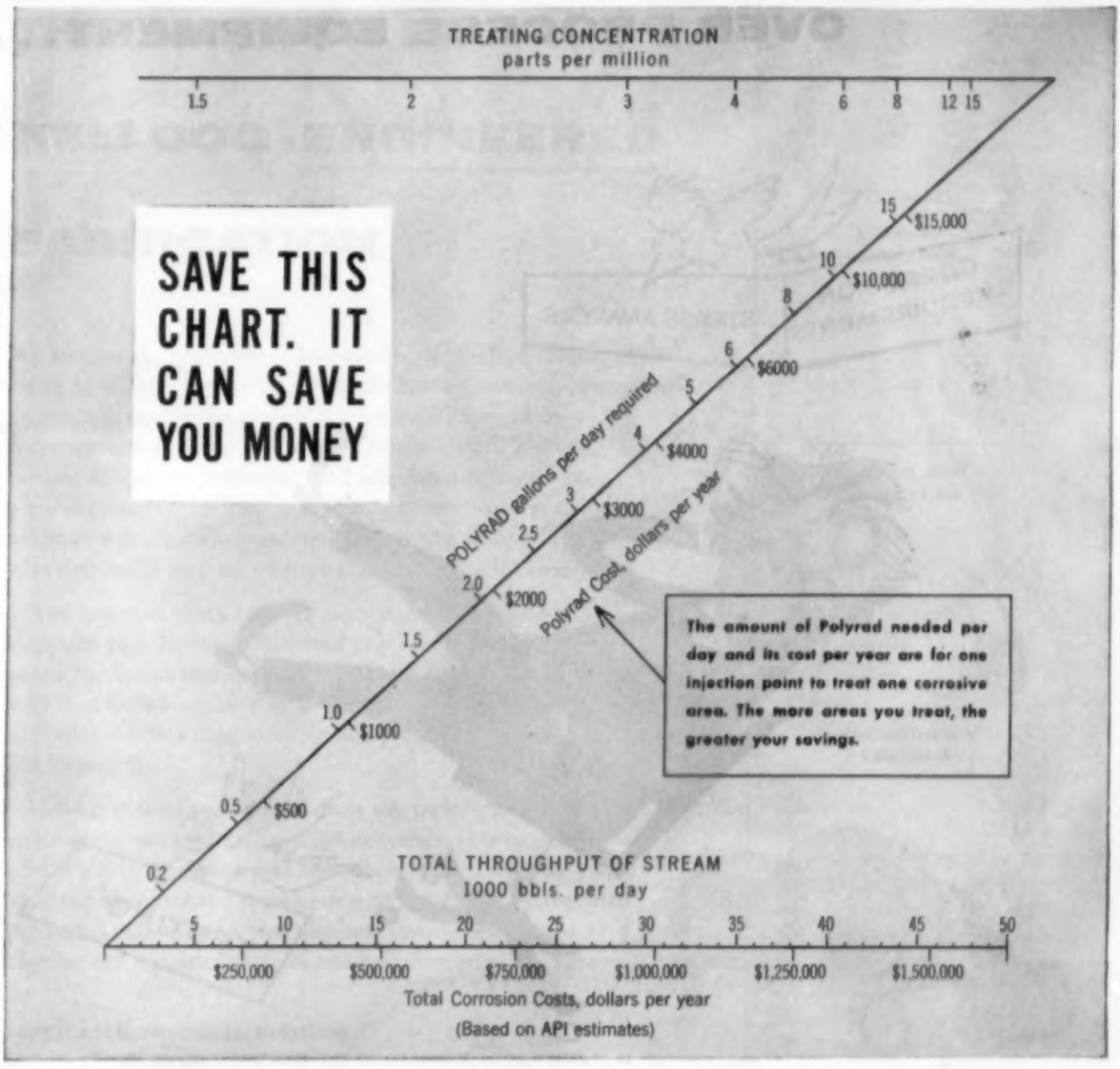
The Nation's Headquarters for Brass & Copper

Albany†	Chicago	Detroit	Los Angeles	New York	St. Louis
Atlanta	Cincinnati	Grand Rapids†	Milwaukee	Philadelphia	San Francisco
Baltimore	Cleveland	Houston	Minneapolis	Pittsburgh	Seattle
Boston	Dallas	Indianapolis	Newark	Providence	Waterbury
Charlotte†	Denver	Kansas City, Mo.	New Orleans	Rochester†	(†sales office only)

CHASE WAREHOUSE STOCKS: Houston,* Los Angeles, New Orleans, Tulsa**

*Handled by Standard Brass & Mfg. Co.
**Handled by Vinson Supply Co.

HOW POLYRAD CUTS CORROSION COST



With this chart you can quickly get an idea of how much you can save in your refinery—at so little cost—with Polyrad corrosion inhibitor. Just connect points at the top and bottom lines with a straight edge. The intersection with the diagonal bar gives the cost of Polyrad to treat that area for one year. The total cost of Polyrad for all areas treated in relation to the total refinery corrosion cost (also shown on bottom bar), indicates the remarkable returns possible.

For example, a refiner treated 25,000 bbl. a day throughput with Polyrad at 6 ppm. at an annual inhibitor cost of $6,000 for this area. In relation to this refinery's total corrosion bill of $800,000 a year, the cost of Polyrad treatments reaped big dividends.

Polyrad is readily available from stocks maintained throughout the country. A Hercules technical representative will be glad to work with you in evaluating this Hercules corrosion inhibitor under your specific operating conditions.

Naval Stores Department

HERCULES POWDER COMPANY

976 Market Street, Wilmington 99, Delaware

POLYRAD®

FILMING AMINE INHIBITOR

WHEN YOU'RE UP IN THE AIR

OVER PROCESS EQUIPMENT...

THE ANSWER IS

KELLOGG-ENGINEERED

FABRICATION

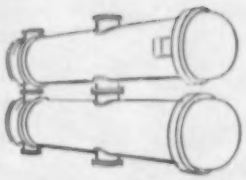
We emphasize "engineered" because M. W. Kellogg means much more than just putting together heat exchangers, pressure vessels, piping and other process equipment. Backed by a complete metallurgical and welding research staff, Kellogg process equipment is designed and fabricated by men who are recognized authorities in the field of heat transfer, stress analysis, welding techniques, non-destructive testing—and who constantly keep up with what is happening for tomorrow.

You can save many precious man-hours for your own engineers with Kellogg-engineered process equipment. You can assign the design problem to Kellogg or have Kellogg review your own design engineering to assure an optimum design. Your engineers will find it stimulating and profitable to work with the Kellogg staff.

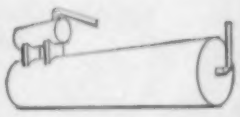
Kellogg process equipment means top performance at minimum investment and prompt deliveries. It is engineered for the job by engineers who *know* their jobs. If recently you have not had firsthand experience with the Kellogg Fabricated Products Division, we would welcome the opportunity to describe our expanded services and manufacturing facilities.

FABRICATED PRODUCTS DIVISION
THE M. W. KELLOGG COMPANY, 225 BROADWAY, NEW YORK 7, N. Y.
In Canada: The Canadian Kellogg Company, Limited, Toronto
In Europe: Kellogg International Corporation, London
SUBSIDIARIES OF PULLMAN INCORPORATED

GET IT RIGHT FROM KELLOGG



HEAT TRANSFER EQUIPMENT



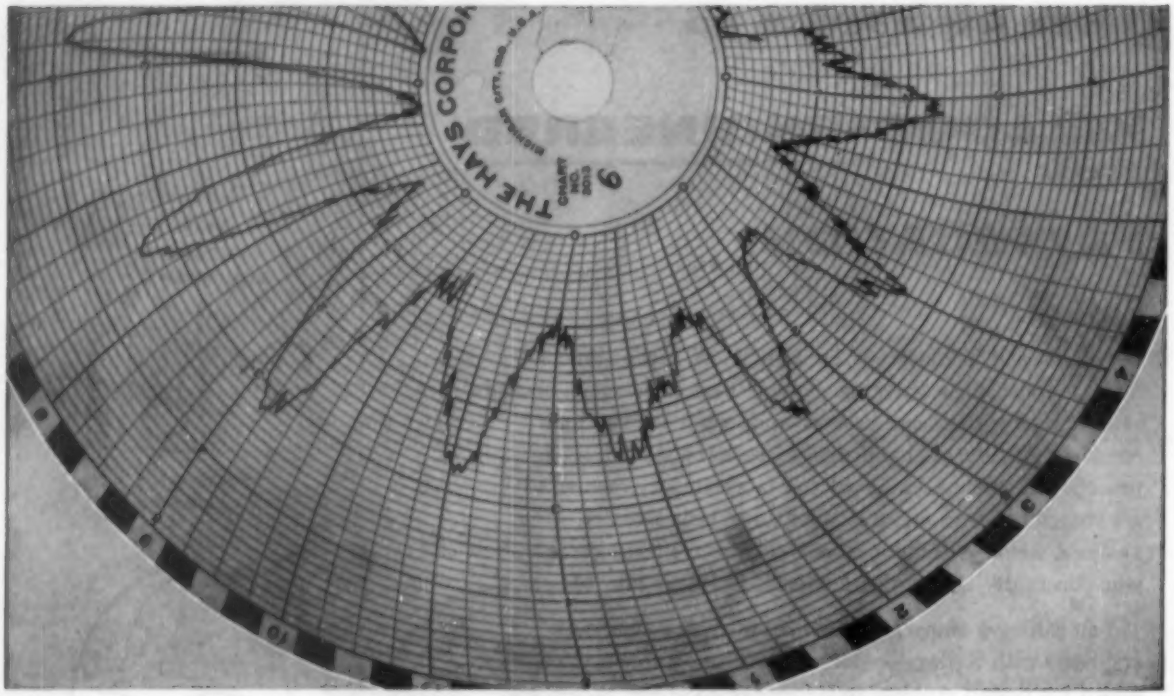
TANKS AND REACTORS

KNOCKDOWN VESSELS

PROCESS PIPING

PRESSURE VESSELS

Portrait of a "team" at work



"Swings" show efforts of new crew before catalyst regenerator was brought to point of operation through use of Hays Magno-Therm O_2 Recorder. Note that swings are smaller at right of chart indicating that stability is being approached.

The chart illustrated above was produced during the starting-up period of a new catalyst regenerator. The wide "swings" on the chart graphically illustrate the efforts of the "team"—a new crew and their Hays Magno-Therm Oxygen Recorder—to operate the unit efficiently. Their problem: To achieve continuous, stable operation thus avoiding "after burning" (excess O_2) which would damage the catalyst and the regenerator as well as too little burning (deficient O_2) which would not effectively regenerate the catalyst.

Solution

Answer to this problem was the "team" operation by crew and Hays Magno-Therm Oxygen Recorder. The "team" now maintains the O_2 content of the effluent gases between .5% and 2.0% thereby producing effective catalyst without damaging the multi-million dollar installation.

The operating crew could do this because the Magno-Therm O_2 Recorder reflects, without lag and in a direct and magnified manner, changes in the amount of excess air present, thus making control a simpler task. No longer need the crew attempt to operate with only indirect, small temperature changes as a guide.

For process heaters and boiler plants

The Hays Magno-Therm Oxygen Recorder has also been successfully and *profitably* applied to process heaters and refinery boiler rooms where multiple fuel firing is a problem.

With the Hays Magno-Therm Oxygen Recorder you get:

• Freedom from effect of varying Hydro-Carbon ratios of different fuels • Continuous, highly accurate indication and recording • Complete compensation for temperature and pressure effects • Freedom from chemicals or hazardous fuel burning in the analyzing process • Swift, sure electronic operation

Hays Bulletin 51-829 tells the complete story of the Magno-Therm. Write for it.

THE HAYS CORPORATION
MICHIGAN CITY 10, INDIANA

Automatic Combustion Control • Boiler Panels • Hays-Penn Flowmeters Veriflow Meters and Veritrol • Gas Analyzers • Draft Gages Combustion Test Sets • CO_2 Recorders • Electronic Oxygen Recorders

For more data on advertised products, use Readers' Service Cards, last page.

POLY-CELL

An Entirely New Type of Insulation

JUST SPRAY . . .
IT FOAMS
AND STICKS!

- NO CUTTING AND FITTING
- NO MECHANICAL FASTENING

Save time insulating valves, fittings and other irregular surfaces. Save on flat areas, too. Fifteen minutes after spraying, POLY-CELL foams to ⅜ inch, 1 inch or any thickness of insulation you desire. It resists acids, alkalies, solvents, sun and other forces.

POLY-CELL's K factor at 75° F. is 0.24 B.t.u. per hour, per square foot, per inch thickness per degree F. Its temperature limit is 225° F., and the density is 2.25 lbs. per cubic foot.

In the field or on the production line POLY-CELL is quickly applied wherever you can point a spray gun.

Insul-Mastic #4010

Insulation's most durable vapor barrier

- STILL THE MOST DURABLE COATING
- KEEPS YOUR INSULATION DRY . . . YOUR VESSELS FREE FROM RUST

What proof of INSUL-MASTIC's quality would you like . . . applications many years old; laboratory vapor barrier and corrosion tests; successful applications in extremely moist or corrosive areas? We can show you all of these. INSUL-MASTIC bituminous coatings have proven their resistance to time, water vapor and most chemicals.

Before you specify, talk to an INSUL-MASTIC technical consultant about vapor barriers, waterproofing, corrosion prevention and insulation. Obtain proper coating recommendations now. There is no obligation for our technical service.

Insul-Mastic

Think first of the coatings that last!

Representatives in Principal Cities

CORPORATION OF AMERICA • OLIVER BUILDING, PITTSBURGH 22, PA.

For more data on advertised products, use Readers' Service Cards, last page.

High boiling point, low volatility and good miscibility characterize Ethylene Glycol and Diethylene Glycol. Highest commercial purity—achieved by a direct oxidation process—characterizes Nitrogen Division Ethylene and Diethylene Glycols.

Available in bulk from Orange, Texas, in 4-, 6-, 8-, and 10,000-gallon tank cars or barges; L.C.L. shipments available in drums and tank trucks from Edgewater, N. J., New York, N. Y., Boston, Chicago, Los Angeles and other key industrial points.

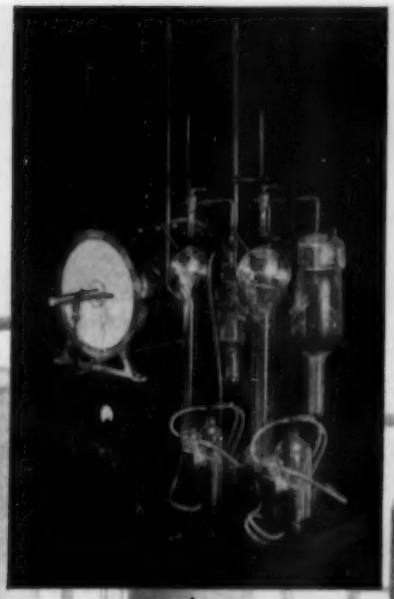
Anhydrous Ammonia
Ammonia Liquor
Ammonium Sulfate
Sodium Nitrate
Methanol
Urea
Ethanolamines
Ethylene Oxide
Ethylene Glycols
Formaldehyde
Nitrogen Tetroxide
Nitrogen Solutions
U.F. Concentrate-85
Fertilizers & Feed Supplements

For help in adapting Glycols to your processes, call Nitrogen Division. An experienced technical service-representative will be pleased to work with you on your technical problems. For early production, act soon. Call or write today!

NITROGEN DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.
Hopewell, Va. • Ironton, Ohio • Orange, Tex. • Omaha, Neb.

Now available COMMERCIALLY

a complete catalyst activity testing unit



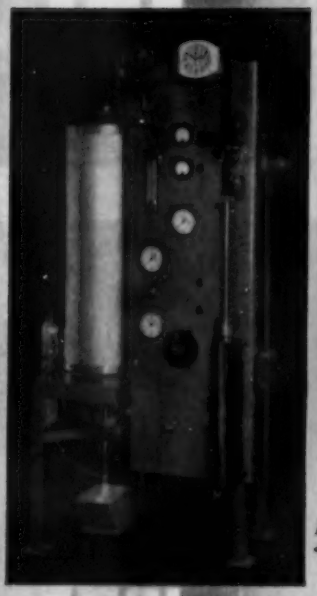
Carbon Determinator Unit ↑

for commercial "Cat" cracking units

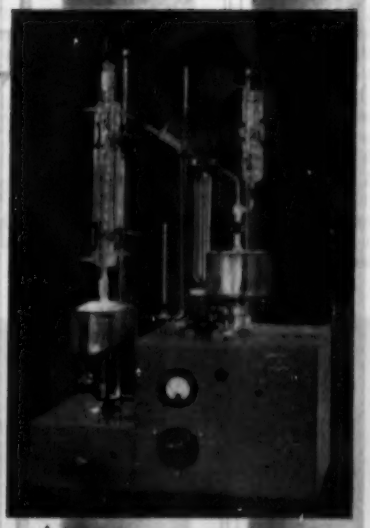
- Evaluates effects of operating variables
- Evaluates feed stocks and mixes
- Aids control of catalyst quality
- Detects catalyst poisoning

for research laboratories

- Evaluates new catalysts



Pump and Reactor Unit ←



↑ *Hempel Column*

Gas Holder ←

This apparatus accurately and quickly determines the activity, carbon producing factor and gas factor of catalysts in one run. Developed by the Standard Oil Company (Indiana) and produced under license from them, its operation is described in two technical papers, copies of which will be sent on request.

Write for bulletins No. 6972 and No. 7551

Leco

LABORATORY EQUIPMENT CORPORATION
ST. JOSEPH 8, MICHIGAN

For more data on advertised products, use Readers' Service Cards, last page.

Fenwal first to apply thermistor principle to indicator-controller design

1. A GREAT STEP FORWARD. In the new *Series 560*, Fenwal engineers have developed the first Indicator-Controller to use a thermistor as the sensing element — an instrument whose many new advantages make it an outstanding value for both industrial and laboratory applications. For example, a selector switch permits either time-proportioning or on-off control, with response accuracy being well within 0.25% of full scale. And its much greater simplicity, excellent stability and ease of maintenance are typical of the Fenwal engineering that has sparked so much progress in the field of temperature control and detection.

2. NO RESISTANCE BULB, NO THERMOCOUPLE. Instead, the *Series 560* employs a super-sensitive thermistor, hermetically sealed in glass and encased in a stainless steel tube. This new sensing element not only probes temperatures from 200° to 600°F with closest accuracy; it also simplifies operation and maintenance by eliminating complex circuitry. Easily adjusted to any desired differential.

3. GET THE WHOLE STORY. Get all the facts on the exceptional accuracy, stability and ease of maintenance of the new *Series 560* Indicator-Controller. You'll find our comprehensive bulletin MC123 on this ahead-of-the-parade instrument well worth reading. For your copy, **write to Fenwal Incorporated, 104 Pleasant Street, Ashland, Mass.**

Fenwal Controls Temperatures ... *Precisely*

"Under Way On Nuclear Power"

As she blinked this terse message, the *USS Nautilus* cast off and steamed to sea leaving an old era of oceanic travel in its wake.

This is the first nuclear-powered, steam-turbine-driven submarine ever to be built. With the eyes of the world watching, it was a project with no margin for failure. Exhaustive sea trials which tested every feature of her equipment proved that the only acceptable result—success—had been completely realized.

We take pride in Walworth's share in this momentous achievement. For, from the days when the *Nautilus* was still on the drawing board to the last stage of construction, Walworth engineers worked directly with the Electric Boat Division of the General Dynamics Corporation—helping with the myriad of piping problems this new concept of transportation posed. Now the *Nautilus* prepares to join the fleet with Walworth Valves and Fittings, both standard and special items, installed.

We are glad to be aboard.

WALWORTH

Manufacturers since 1842

valves . . . pipe fittings . . . pipe wrenches

60 East 42nd Street, New York 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS
THROUGHOUT THE WORLD

For more data on advertised products, use Readers' Service Cards, last page.

At last!

A TRUE VINYL MASTIC!

Complete protection in a single coat—10 mils thick.

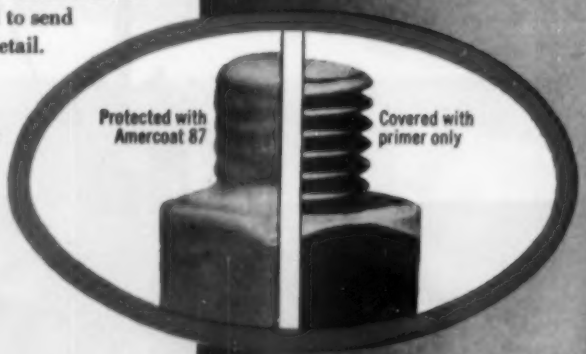
Amercoat No. 87 will cut your maintenance costs because one coat gives you the thickness and protection previously available only through the application of multiple coats.

Amercoat No. 87 is the brand new solution to an old problem, for it combines the time-tested chemical and weather resistance of a vinyl with the extra thickness that was heretofore available only in conventional mastics.

Amercoat No. 87 is easily applied with standard industrial spray equipment. Only one cross-spray coat, over a primed surface, is required for complete protection. Because **Amercoat No. 87** is a true vinyl, it is not limited to black, but is available in a variety of colors.

You can save up to 50% of your labor costs with **Amercoat's new vinyl mastic No. 87.** We will be pleased to send you a bulletin describing this new coating in detail.

Notice that the sharp bolt threads, welds and sharp corners are completely protected with one coat of Amercoat No. 87—10 mils thick!



Amercoat CORPORATION

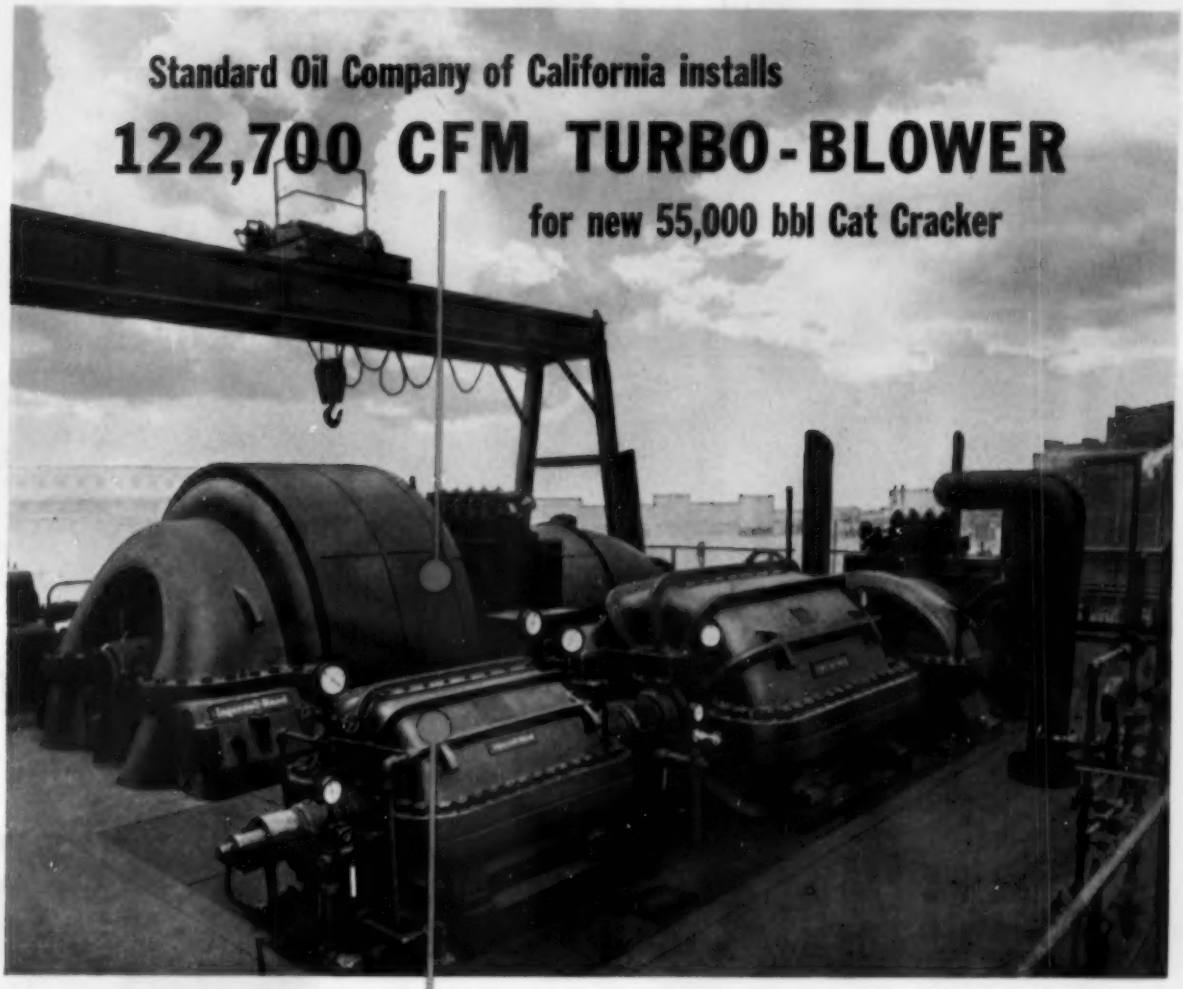
Dept. RD.
4809 Firestone Blvd.,
South Gate, California

EVANSTON, ILL. • KENILWORTH, N.J. • JACKSONVILLE, FLA. • HOUSTON, TEX.

Standard Oil Company of California installs

122,700 CFM TURBO-BLOWER

for new 55,000 bbl Cat Cracker



Outdoor Installation at El Segundo Refinery also includes the world's largest centrifugal gas compressor in catalytic service ... both by Ingersoll-Rand

THIS INSTALLATION at Standard Oil Company of California's huge El Segundo refinery is unique in three respects.

The 122,700 cfm I-R Turbo-Blower shown in the background is one of the largest ever supplied for refinery service. It is a 3-stage unit, driven by an I-R 10,000 hp steam turbine, delivering air at 19.35 psig to the 55,000 barrel per day cat cracker.

In the foreground is the largest centrifugal refinery gas compressor in the world — a 6370 hp I-R unit consisting of two centrifugals in tandem, driven by an I-R turbine. Compressing gas from 4 psig to 205 psig, it delivers 20,800 cubic feet per minute.

The entire installation is out of doors.

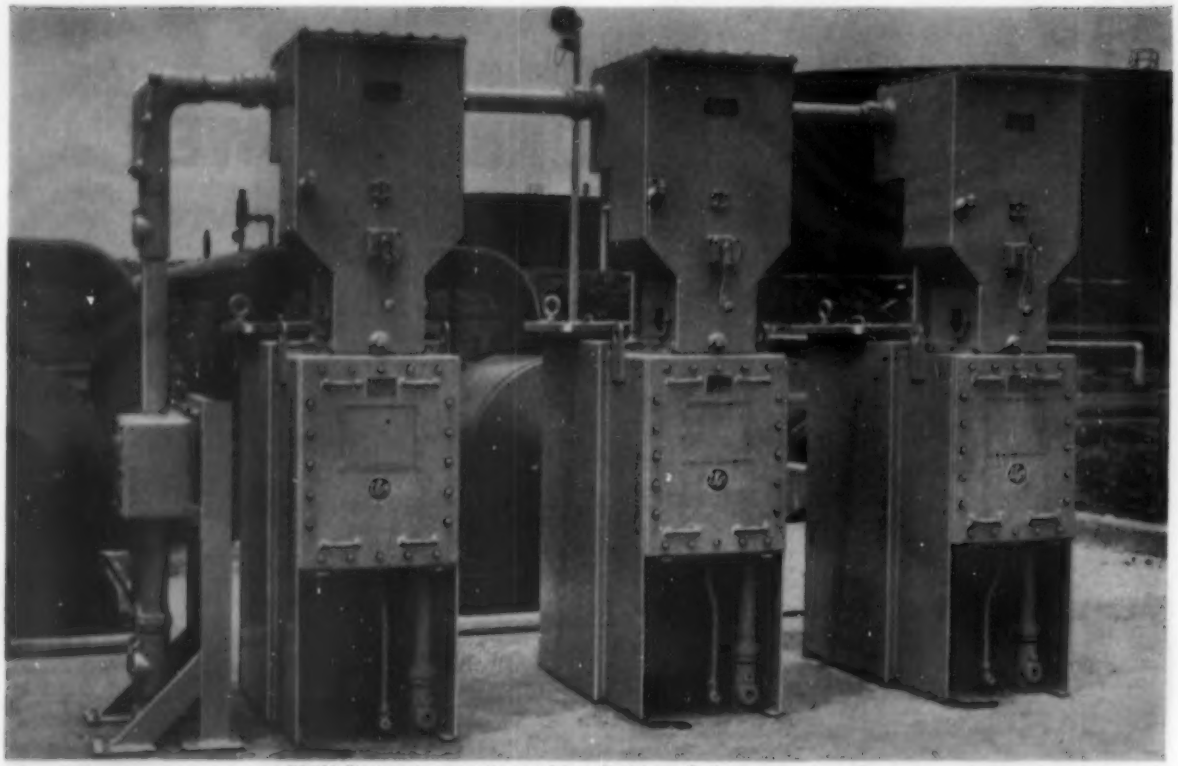
Whatever *your* requirements for refinery air or gas compression, Ingersoll-Rand's unequalled experience and facilities are at your service.

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

12-191

COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO-BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • DIESEL AND GAS ENGINES

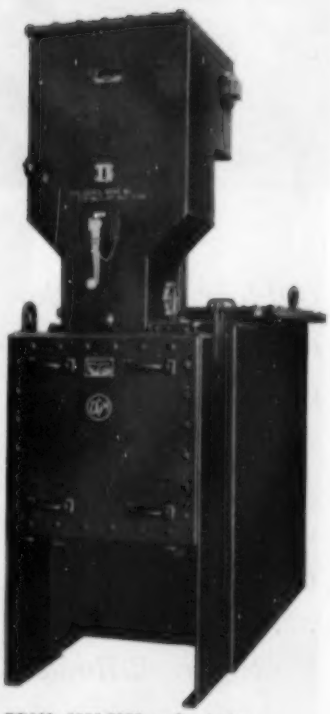


EC&M Starters in operation at large Louisiana Refinery.

FULL PROTECTION FOR VITAL DRIVES with EC&M 2200 - 5000 VOLT Motor Starters

- **SAFE OPERATION** — Starters are designed for requirements of Class I, Group D hazardous locations, with main motor circuits made and broken under oil.
- **HIGH INTERRUPTING CAPACITY** — EC&M Starters are rated at 50,000 KVA interrupting capacity based on *certified tests*. For higher ratings, these starters are built in the VALIMITOR style (oil-immersed reactors limit infinite KVA to a finite value easily cleared by the starter).
- **PERSONNEL PROTECTION** — Combination type with Oil Disconnect Switch has view window on each side to show position of disconnect contacts.
- **MOTOR PROTECTION** — Thermal-Magnetic Overload Relays guard motors by inverse time on overloads . . . trip instantly on fault currents.
- **LUBRICATED AND PROTECTED** — EC&M Starters require infrequent inspection and minimum maintenance because oil immersion protects the starter mechanisms from corrosive atmospheres.
- **COMPACT NEAT INSTALLATION** —Starters require little mounting space, allowing ample room around each unit for inspection and maintenance.

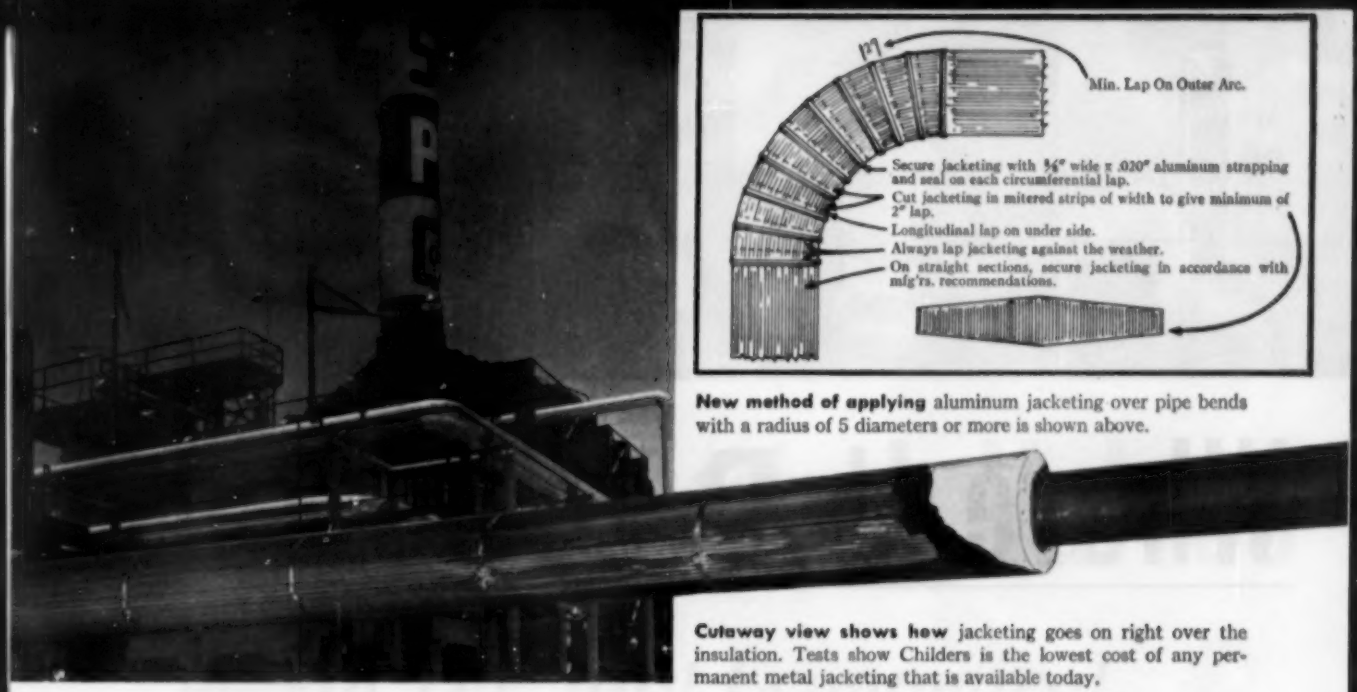
Write for booklet 1062
Describing and illustrating EC&M Motor Starters for petroleum applications.



EC&M 2200-5000 volt starter with self-contained oil disconnect switch.

THE ELECTRIC CONTROLLER & MFG. CO.
2698 East 79th Street ★ Cleveland 4, Ohio

6025


Min. Lap On Outer Arc.
Secure jacketing with ¾" wide x .020" aluminum strapping and seal on each circumferential lap.
Cut jacketing in mitered strips of width to give minimum of 2" lap.
Longitudinal lap on under side.
Always lap jacketing against the weather.
On straight sections, secure jacketing in accordance with mfg'rs. recommendations.

New method of applying aluminum jacketing over pipe bends with a radius of 5 diameters or more is shown above.

Cutaway view shows how jacketing goes on right over the insulation. Tests show Childers is the lowest cost of any permanent metal jacketing that is available today.

Only pliers and pocket knife needed to apply easy-to-handle Childers Aluminum Jacketing

Best method of applying jacketing is with aluminum strapping and seals. Other method is to use sheet metal screws.

Aluminum strapping can be pulled tight enough with just pliers. Lugs are then bent over and fastening is complete.

Eastern States Petroleum's two-man crew covers insulated lines, even L's and bends—using light-weight, weatherproof aluminum jacket.

Childers Jacketing for insulated lines, made of .006" 3S alloy aluminum, was used to cover thousands of feet of line in Eastern States Petroleum's Houston plant.

As it does in over 1000 other plants in all 48 states and many foreign countries, Childers Jacketing helped save Eastern States many expensive hours of application and maintenance time.

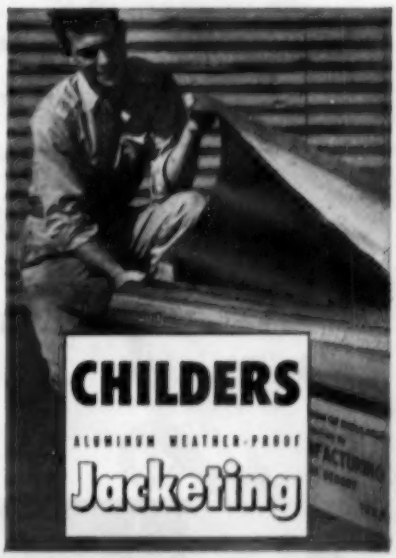
In fact, tests show this: Two men, working with Childers Jacketing for the first time, can cover more feet of insulated line in a day than with practically any other kind of covering. This means real savings in application costs.

The cost is low, too. You can actually put aluminum jacketing on your lines for less than the cost of the cheapest weatherproofing when one paint job is considered.

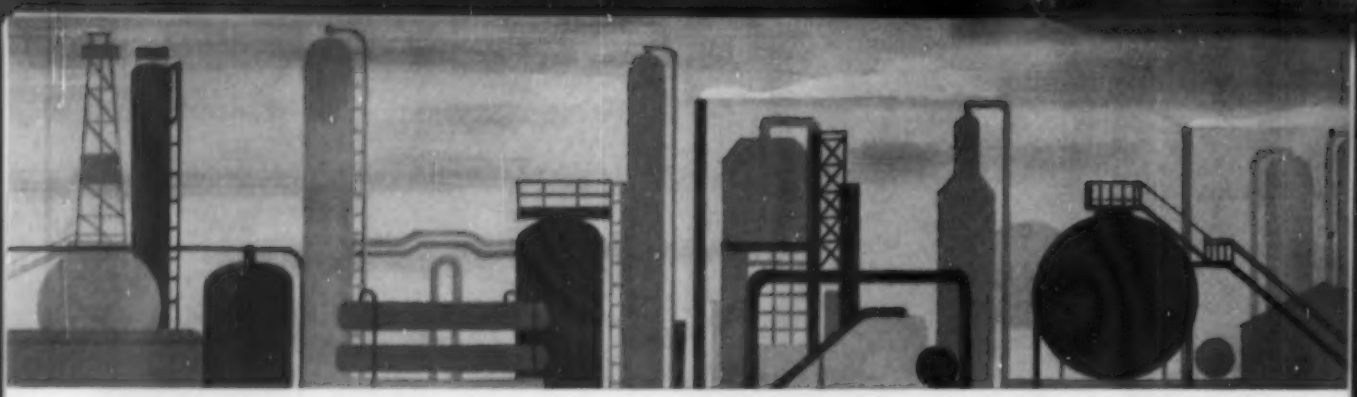
Immediate shipment from our large factory stocks can eliminate costly delays in construction or plant improvement schedules.

Try this low cost protection in your plant. Write today for engineering data and information about how you can order a 400 sq. ft. roll to test on one of your insulated lines. No obligation. Address: Childers Manufacturing Company, Department PR-25 3620 West 11th Street, Houston, Texas.

Engineering representatives in most cities to work with you on jacketing problems.



Childers Jacketing arrives on the job in convenient rolls 4 feet wide and 100 feet long—easy for one man to handle. Jacketing comes with or without a moisture barrier attached to the back of the .006" aluminum. Rolls are well protected for field storage if kept dry. Boxes light enough for one man to carry. (Adv.)

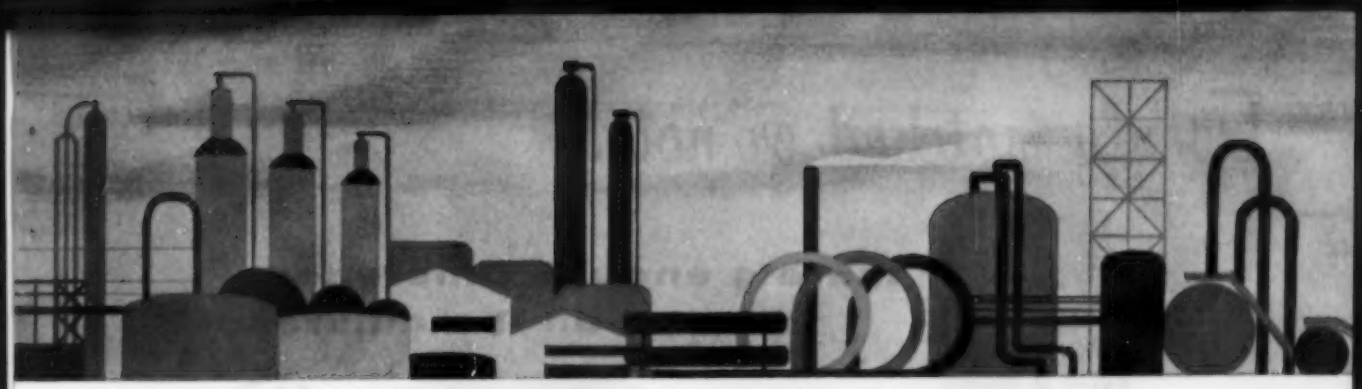


Where It PAYS To Use

REFINERY VALVE CHECK LIST

Where To Use ROCKWELL-NORDSTROM Valves

- ☑ Crude Lines To Refinery
- ☑ Heater Lines
- ☑ Towers
- ☑ Relief Valve Settings
- ☑ Lube Oil Treating
- ☑ Blending Lines
- ☑ Dewaxing
- ☑ Filtering
- ☑ Transfer Lines
- ☑ Solvent Extraction
- ☑ Products Lines
- ☑ Tank Farms
- ☑ Loading Racks
- ☑ Fuel and Supply Lines
- ☑ Cat Crackers
- ☑ Platforming Units



Rockwell-Nordstrom Valves

For The Most Economical, Trouble-Free Refinery Valve Service

Look very carefully at the refinery valve check list on the left. If you are not now using Rockwell-Nordstrom valves at these important points, you have a real opportunity to make worth-while savings through longer, more trouble-free valve life, and lower repair, replacement and down time costs. Here are the reasons:

ECONOMICAL: Rockwell-Nordstrom valves are the most economical refinery valves you can use. Pressurized lubrication—which forms the time-proven leakproof seal—also eliminates metal-to-metal friction and "armor plates" the working parts against corrosive or erosive line material. And the valve seats, the parts that are "eaten out" fastest on ordinary valves, are *never* exposed to line material.

Rockwell-Nordstrom valves will start saving money for you the day they go on-stream because lubrication and rugged design eliminate costly repair and replacement and assure longer economic valve life.

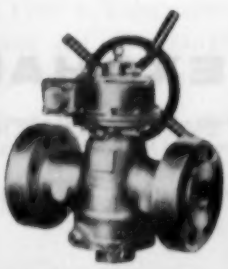
TROUBLE-FREE: Refinery engineers have been standardizing on Rockwell-Nordstrom valves for forty years. They've learned that the pressurized lubricant seal and positive shut-off assure *safe*, leakproof operation in *any* refinery service. Refinery operations men prefer Rockwell-Nordstrom valves because quarter turn closure permits accurate, smooth flow control. There are no bulky, large open cavities on Rockwell-Nordstrom valves; they require less space in manifolds. "Open-Close" guess work is eliminated—a glance at the wrench instantly tells plug position.

Rockwell-Nordstrom valves are available in *the only complete range* of lubricated plug valve sizes and pressure-temperature ratings in steel, semi-steel and corrosion resisting alloy patterns. Write for complete information today: Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Canadian Valve Licensee: Peacock Brothers Limited

ROCKWELL-Nordstrom VALVES

LUBRICANT SEALED FOR POSITIVE SHUT-OFF



Evenly matched or not...

there's enough difference to make all the difference

Before the bout, two fighters may look equally good to the fans. After a round or two, the differences begin to show up.

It's the same with heat exchanger tubes. They all start out looking pretty much alike, but under the test of day-in, day-out operation, Scovill Phosphorized Admiralty Heat Exchanger Tubes have consistently shown superior performance.

Hot-extrusion from Scovill Continuous-Cast billets means uniformity in the metal, uniformity of chemical composition and grain structure, uniformly high phosphorus content. It means sounder metal—smooth, dense, free from pits or porosity. These—plus Scovill's unrivaled Technical Application Services—are, indeed, differences that make *all* the difference in economical, uninterrupted service under tough operating conditions. Let us tell you more about them.

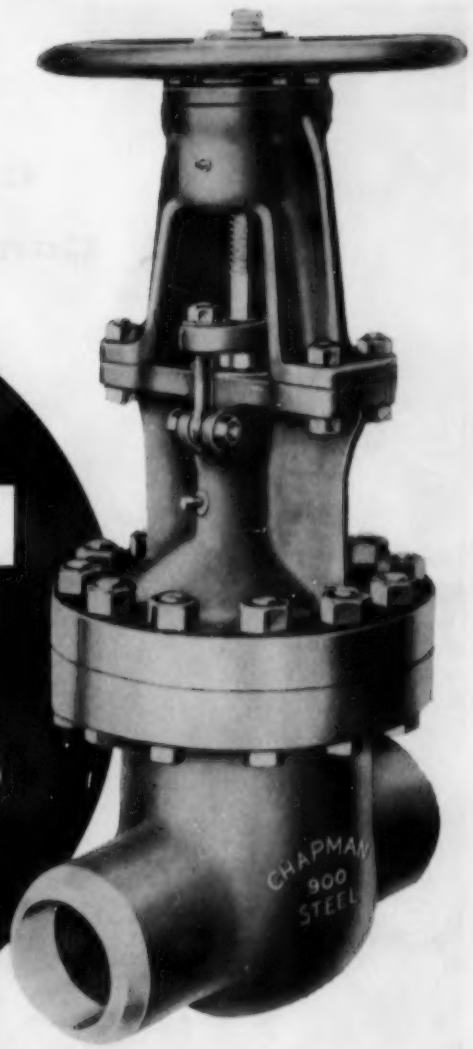
Scovill Manufacturing Company, Mill Products Division, 99 Mill Street, Waterbury 20, Connecticut. Phone PLaza 4-1171.

SCOVILL **HEAT EXCHANGER TUBE**

Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Muntz Metal • Naval Brass • Red Brass, 85% • Deoxidized Copper
Arsenical Copper • Copper Nickel, 10% & 20% • Cupro Nickel, 30% • Aluminum Brass • Aluminum Bronze, 5% • Duplex Tube

99CS9

Specify CHAPMAN STEEL VALVES in any of the Standard Alloys to meet your steel valve needs



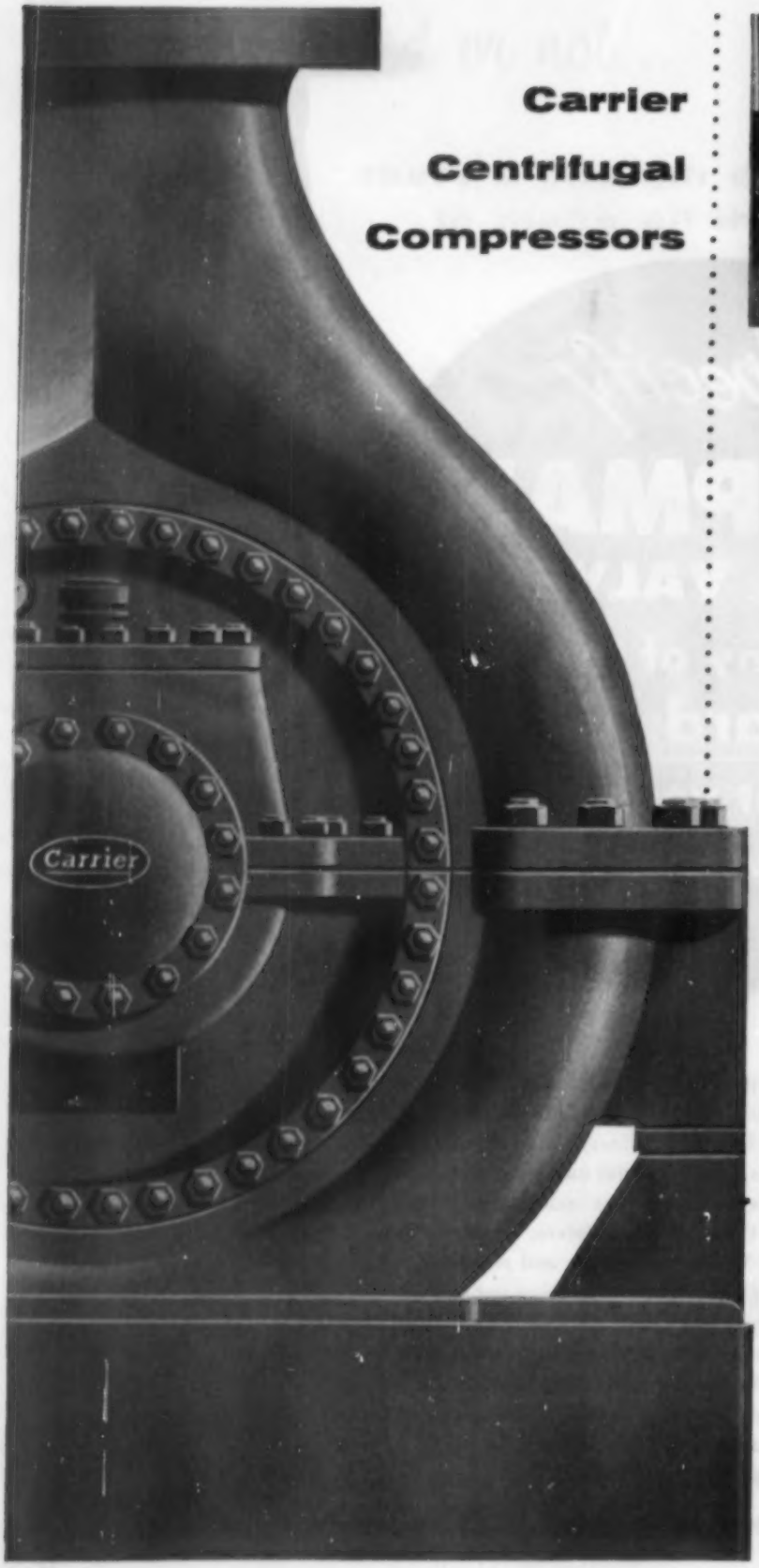
When you specify Chapman Steel Valves you also specify valve steels designed for your specific services. Standard alloys match every normal oil industry requirement. Special alloys can be furnished for extraordinary service conditions. All metals are poured in Chapman's own foundries under rigid laboratory supervision.

Exceptionally close machining tolerances are another standard feature of Chapman Steel Valves. Under the most severe conditions, Chapman Steel Valves seat tightly and positively, without jamming, chattering or wearing excessively. Operation remains smooth and dependable; maintenance costs stay low.

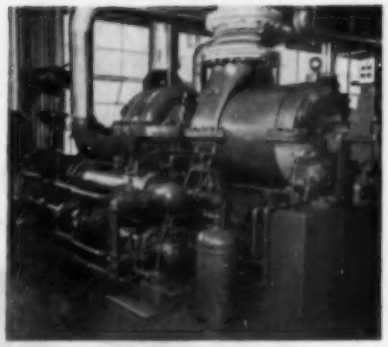
See Chapman *first* for gates, globes and checks in all pressure classes — 150, 300, 400, 600, 900 and 1500 pounds — and for temperatures from —150°F to 1200°F. Valves are available with bolted or welded body and bonnet joints and with flanged or welding ends. API standards are equalled or exceeded in every range. Write for Catalog No. 20.

THE CHAPMAN VALVE MANUFACTURING COMPANY
INDIAN ORCHARD, MASSACHUSETTS

For more data on advertised products, use Readers' Service Cards, last page.



Carrier Centrifugal Compressors



on the job at

Southwest Gas Producing Company

This is one of two Carrier Centrifugal Compressors handling propane for lean-oil cooling in the Dubach, Louisiana, plant of the Southwest Gas Producing Company. Successful experience with a Carrier unit installed on the job in 1948 led to the installation of a second unit in 1951.

Carrier makes a complete line of centrifugal and axial flow compressors for gas compression and refrigeration — up to 10,000 hp. in a single unit. There are hundreds of these dependable, efficient Carrier machines on the job at dozens of refineries across the country—The Atlantic Refining Company, Cities Service Oil Company, The Texas Company. May we assist you?

If you'd like a copy of our booklet, **"Centrifugal Compressors for Industry,"** please call your nearest Carrier office. Or write direct to Carrier Corporation, Syracuse, New York.

Carrier

centrifugal compressors
refrigerating equipment

STAINLESS STEEL

...fights corrosion...solves many piping problems

● Stainless steel piping, using TUBE-TURN* Stainless Steel Welding Fittings, can provide long, safe service where corrosive gases or fluids are handled. Likewise, stainless steel systems are superior where temperature extremes are encountered, for handling dangerous materials safely, for preventing contamination.

Tube Turns offers a *complete line* of Stainless Steel Welding Fittings in three analyses: AISI Type 304, Type 347, and Type 316; and in four schedules: 5S and 10S (thin wall), and 40S and 80S (heavy wall). For the *right* stainless steel welding fittings, and for help in proper application, get in touch with your Tube Turns' Distributor. You'll find one in every principal city.

TUBE-TURN Welding Fittings and Flanges are made in U.S.A.
They meet all U.S. piping code specifications

TUBE TURNS LOUISVILLE 1, KENTUCKY

A Division of National Cylinder Gas Company

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Cleveland • Detroit • Chicago • Denver • Los Angeles San Francisco • Seattle • Atlanta • Tulsa • Houston • Dallas • Midland, Texas

*"tt" and "TUBE-TURN" Reg. U.S. Pat. Off.

STAINLESS DATA

How you get *extra service* from TUBE-TURN* Stainless Steel Welding Fittings

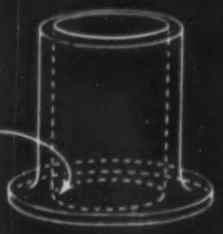
EXTRA-VALUE FEATURES AT NO EXTRA COST

UNIFORM WALL ASSURES UNIFORM STRENGTH

All TUBE-TURN Welding Elbows meet ASA B16.9 and MSS SP43 Standards on minimum wall thickness of 87½% of nominal thickness — particularly important on thin wall welding elbows. Many elbows on the market are as much as 30% to 40% below nominal thickness at this point of greatest wear. Wall thickness is likewise uniform on the inside radius — no "bunching up" of metal.

MATCHES PIPE BURSTING STRENGTH

Welding Tees are adequately reinforced. Along with other TUBE-TURN Welding Fittings their strength matches the calculated bursting strength of the pipe.



NO CORROSION POCKETS

TUBE-TURN Lap Joint Stub Ends have a square inside corner which eliminates a "corrosion pocket" and a proper fillet radius which assures strength under flexing and vibration.

CHECK THESE FEATURES

Only TUBE TURNS offers them all

- Fittings meet standard chemistry specifications
- Minimum wall thickness of elbows 87½% of nominal
- Fittings meet minimum calculated bursting pressure of matching pipe
- Qualified welders and procedures used where welding is required
- Each fitting properly solution heat treated
- Each fitting passivated
- Other special grades of stainless steel, and all other alloys available

All these extra value features available to you at no extra cost.

MEET ALL CODES

TUBE-TURN Stainless Steel Welding Fittings meet all specifications: ASTM A312 (for material); MSS SP43 and ASA B16.9 (for dimensions); and MSS SP25 (marking procedure).

IMPORTANT DATA...

"Stainless Steel Pipes . . . Why and Where to Use It"—Advantages of stainless steel, types, selection of size, pipes, service requirements, avoidance of contamination, welding, heat treatment, etc. Mail coupon for free book.

TUBE TURNS, Dept. Y-2
224 East Broadway, Louisville 1, Kentucky
Please send STAINLESS STEEL "WHY AND WHERE" book.

Company Name _____

Company Address _____

City _____ *Zone* _____ *State* _____

Your Name _____

Position _____

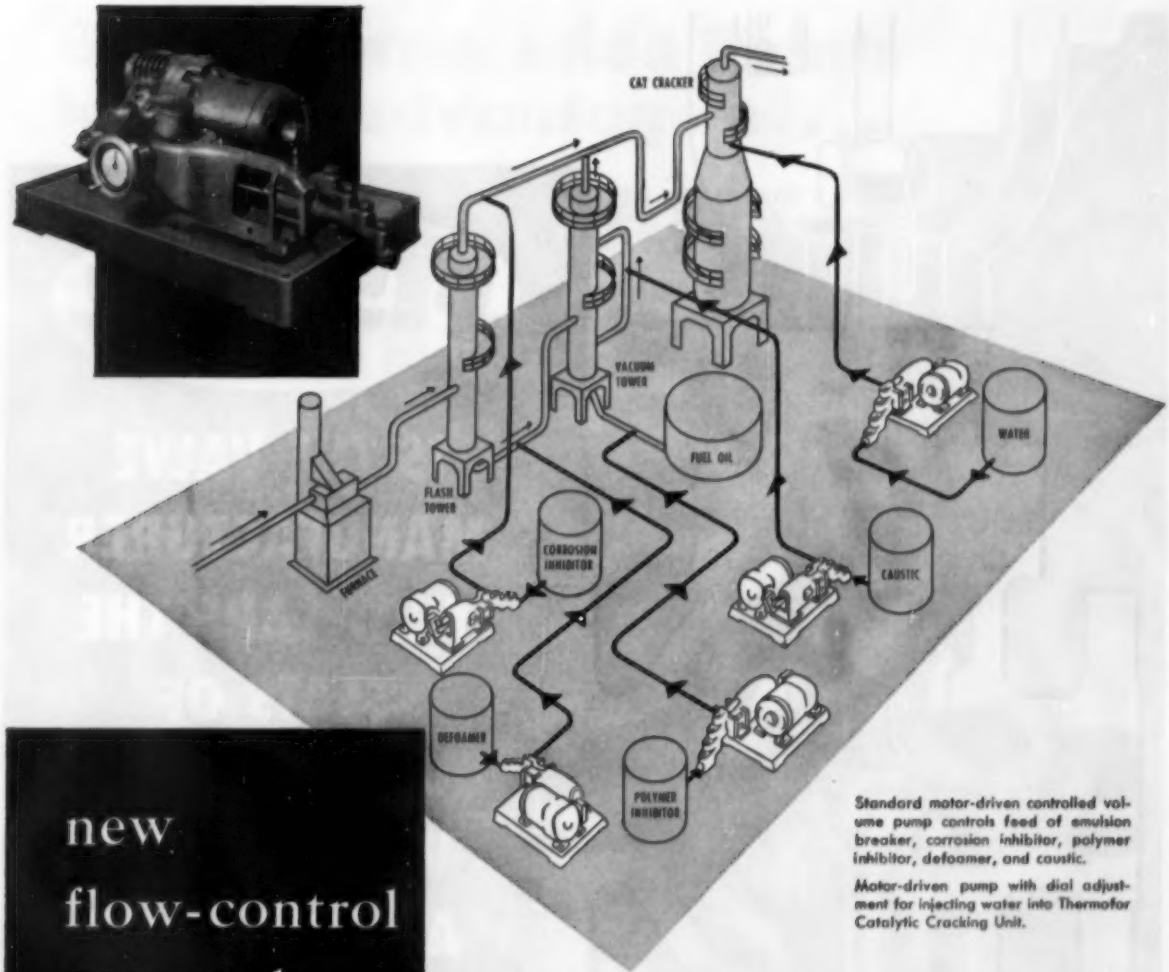
DISTRICT OFFICES

New York	Los Angeles
Philadelphia	San Francisco
Pittsburgh	Seattle
Cleveland	Atlanta
Chicago	Tulsa
Detroit	Houston
Denver	Dallas
Midland, Texas	

* "tt" and "TUBE-TURN" Reg. U. S. Pat. Off.

TUBE TURNS

A DIVISION OF NATIONAL CYLINDER GAS COMPANY
LOUISVILLE 1, KENTUCKY



Standard motor-driven controlled volume pump controls feed of emulsion breaker, corrosion inhibitor, polymer inhibitor, defoamer, and caustic.

Motor-driven pump with dial adjustment for injecting water into Thermofor Catalytic Cracking Unit.

new flow-control approach

for precise metering of defoamers, additives, corrosion inhibitors, and other low-capacity chemical flows against a head

Controlled volume pumps are flow control instruments

A NEW approach to low-capacity flow control is making big news in the petroleum processing industry. Additives, inhibitors, defoamers, octane appreciators, demulsifiers, reagents, and other chemicals are being metered with new accuracy by Milton Roy *controlled volume pumps*. Advantages are many. —More precise flow control. Better quality control. Positive corrosion control. Reduced chemical costs.

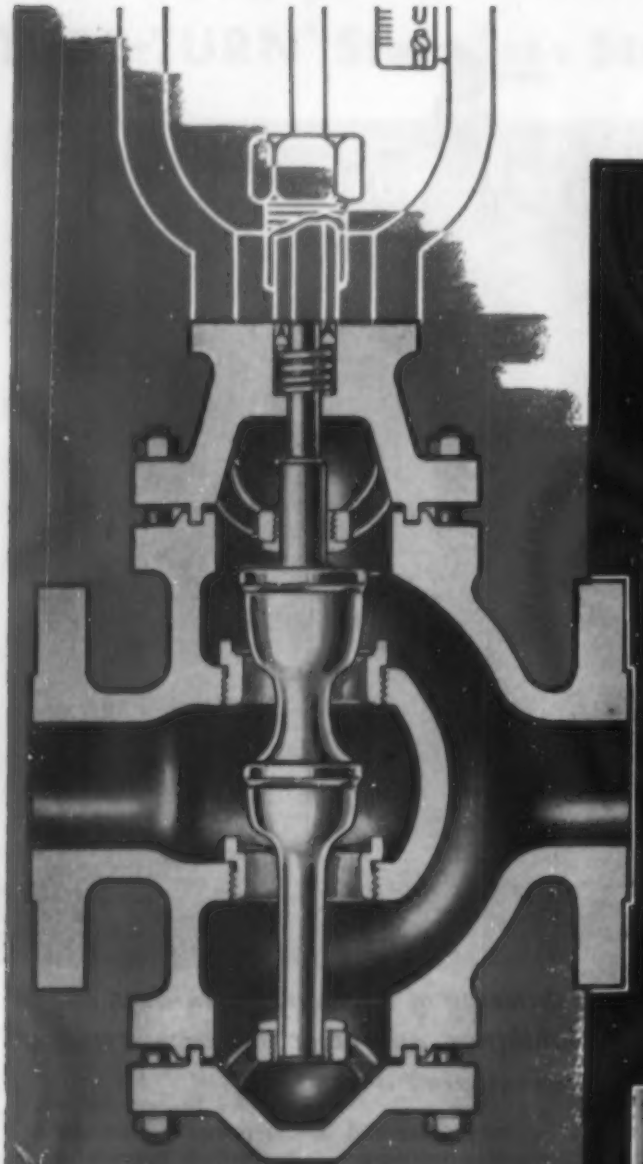
Here's why. Controlled volume pumps are actually flow control instruments . . . particularly valuable for low-capacity flows. They precisely meter process chemicals—volatiles, acids, even heavy oils and sludges—to within 1% accuracy.

Milton Roy offers you long experience in handling low-capacity flow control problems . . . in engineering complete chemical feed and automatic control systems. Write for Bulletin 1253 "Controlled Volume Pumps in Process Instrumentation". Or, send your problem to Milton Roy Company, *Manufacturing Engineers*, 1300 East Mermaid Lane, Phila. 18, Pa.

Engineering representatives in the United States, Canada, Mexico, Europe, Asia, South America, and Africa.

milton Roy
CHEMICAL FEED SYSTEMS

For more data on advertised products, use Readers' Service Cards, last page.



FISHER®

IS THE VALVE MANUFACTURER THAT LAPS THE SEATS OF DOUBLE PORTED VALVE BODIES AT OPERATING TEMPERATURES

Fisher valve being steam heated to specified operating temperature.

Inner valve being "ground in" while assembly is hot.

Insures superior control with tighter shut-off on high temperature service. Both upper and lower seating surfaces contact simultaneously at specified operating temperatures.

FISHER GOVERNOR COMPANY • MARSHALLTOWN, IOWA

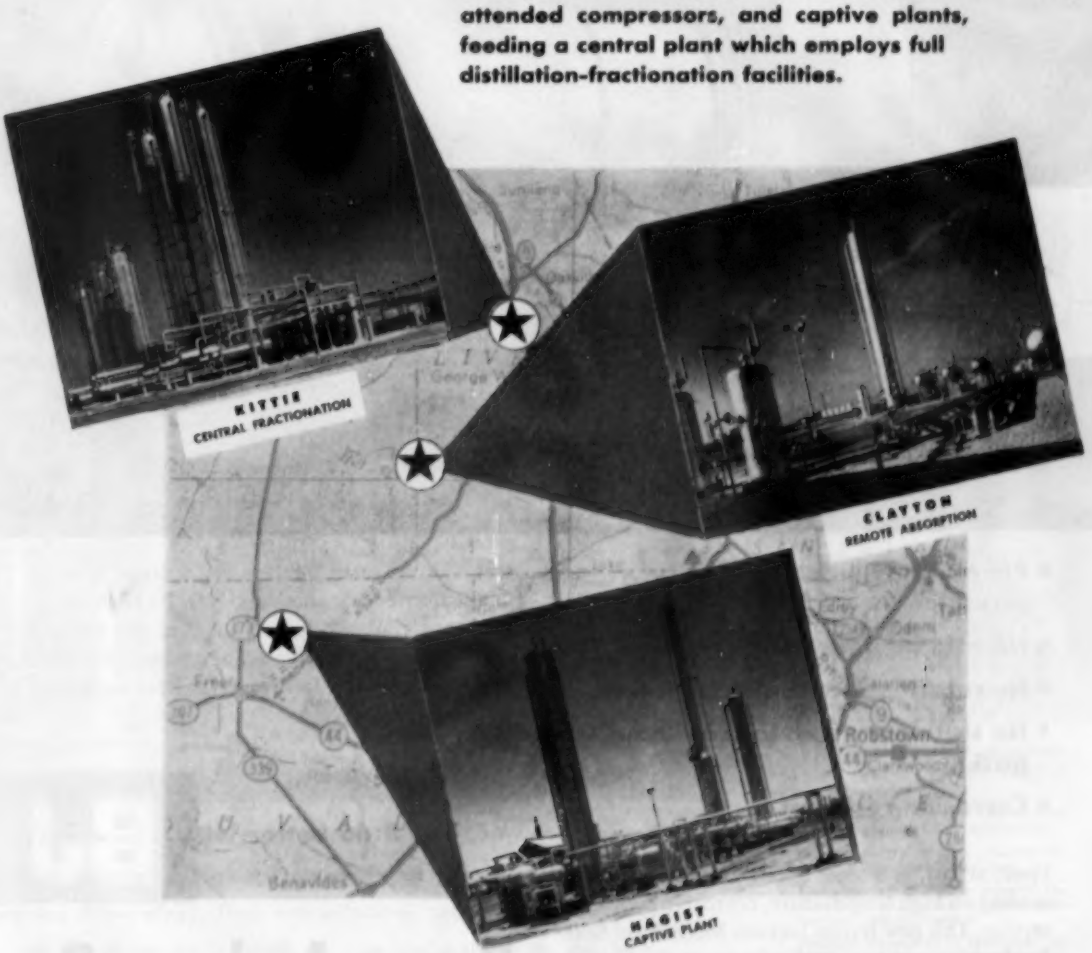
WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

FISHER Our 75th ANNIVERSARY

Goliad Corporation Plants take full advantage of...

CAPTIVE PLANT–
REMOTE ABSORPTION
Techniques

Unique processing of small, scattered gas reserves is daily working for Goliad Corporation through the use of remote absorbers, unattended compressors, and captive plants, feeding a central plant which employs full distillation-fractionation facilities.



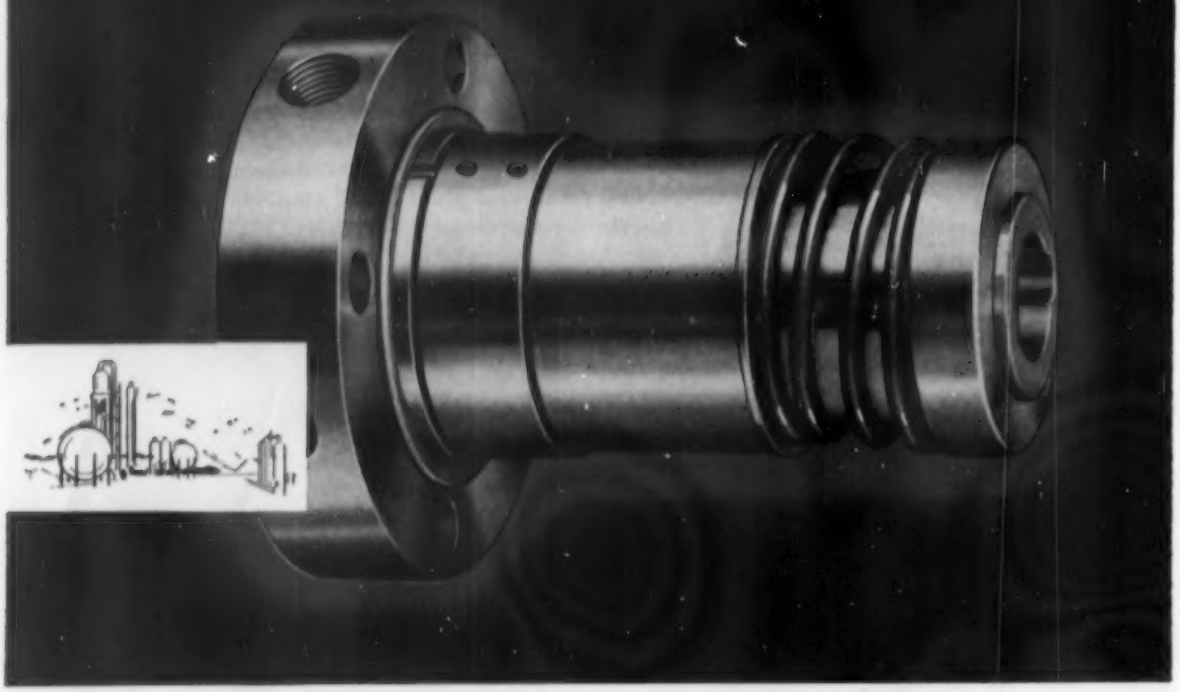
GASOLINE PLANT CONSTRUCTION CORP.

ENGINEERS . . . DESIGNERS . . . CONSTRUCTORS

NEILS ESPERSON BUILDING, HOUSTON • WILSON TOWER, CORPUS CHRISTI

For more data on advertised products, use Readers' Service Cards, last page.

this new BJ mechanical seal takes temperatures up to 800°F!



- **Proven in high temp refinery service**
- **No cold oil injection required**
- **No rotating face to sleeve gasket**
- **No stationary face to seal flange gasket**
- **Corrosion-resistant**

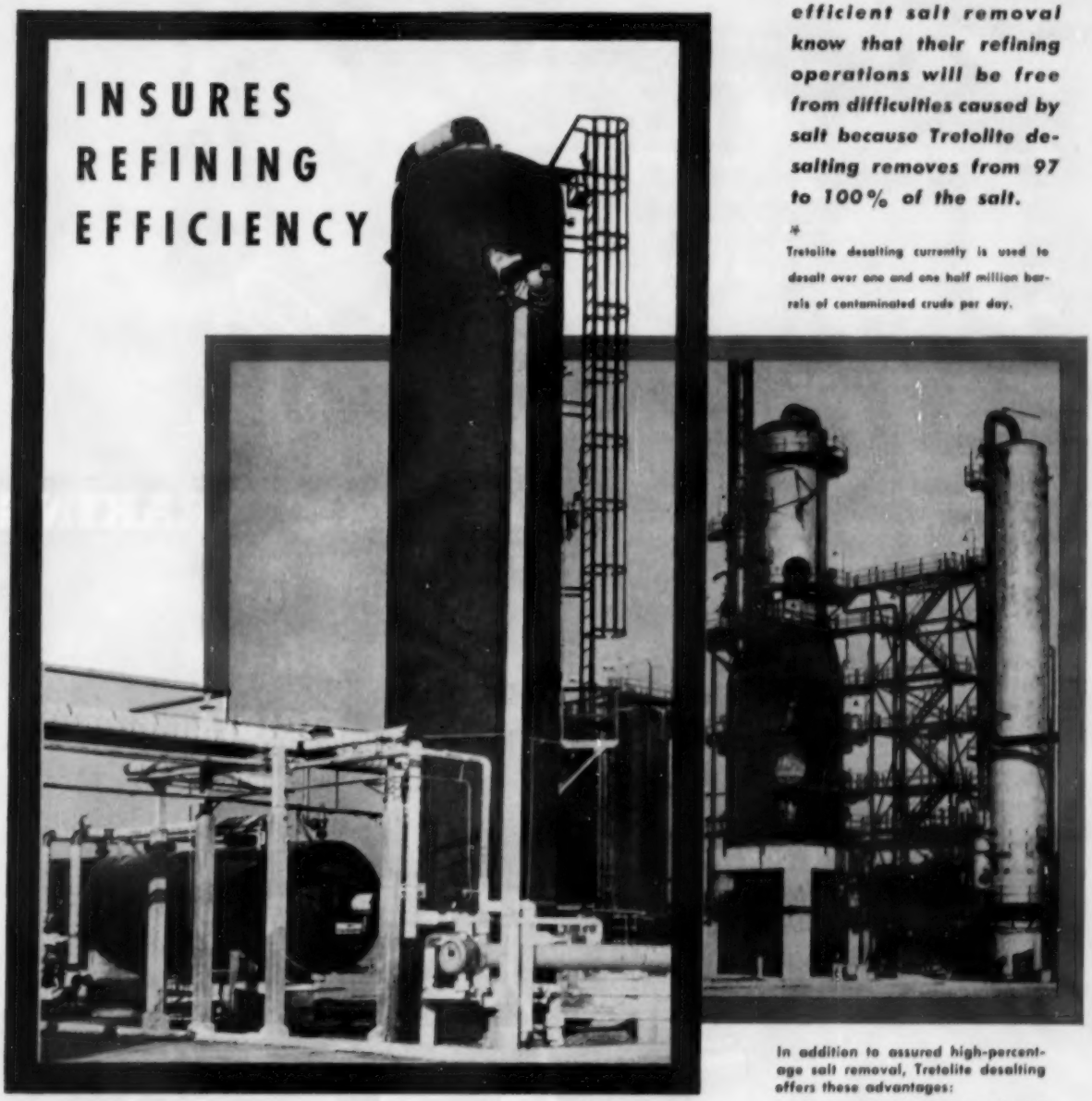
Here, at last, is a safe, effective answer to shaft sealing on high temperature, corrosive pumping service. This new Byron Jackson Mechanical Seal has been proved in rugged refinery service including hot asphalt and hot oil pumping (up to 800°F). It requires no cold oil injection, needs no auxiliary pumping for coolant. It is an all metal precision seal with no gaskets except shaft sleeve to shaft and seal cover to stuffingbox. New BJ High-Temp Seals are available now in any size and for any pressure encountered in refinery operation. Call your nearby Byron Jackson sales office for details or write.

You'll do better with BJ

Byron Jackson Co.
PUMP DIVISION
Since 1872
P. O. BOX 2017, TERMINAL ANNEX, LOS ANGELES 54, CALIFORNIA

TRETOLITE DESALTING

INSURES REFINING EFFICIENCY



The many* refiners who depend on Tretolite for efficient salt removal know that their refining operations will be free from difficulties caused by salt because Tretolite desalting removes from 97 to 100% of the salt.

* Tretolite desalting currently is used to desalt over one and one half million barrels of contaminated crude per day.

As an additional insurance against lost refining efficiency caused by corrosion damage, ask your Tretolite Refinery Engineer about Kontol Corrosion Preventives. They are effective, economical, and proved.

TRETOLITE COMPANY

A DIVISION OF PETROLITE CORPORATION

369 Marshall Avenue, St. Louis 19, Missouri • 5515 Telegraph Road, Los Angeles 22, California

Specialized Chemicals and Services for the Petroleum Industry

DEMULSIFYING • DESALTING • WATER DE-OILING
CORROSION INHIBITING • PARAFFIN REMOVAL • SCALE PREVENTION • PRODUCTION STIMULATION

In addition to assured high-percentage salt removal, Tretolite desalting offers these advantages:

1. ***The low treating cost per barrel results in economical operations.***
2. ***The simplicity of the process assures a low installation cost.***
3. ***Flexibility of operation permits the desalting of various crudes with varying salt contents.***
4. ***Emulsion resolution is thorough, resulting in a clean water effluent.***
5. ***Solids such as sand, silt and drilling mud are effectively removed, preventing plugging and erosion.***
6. ***Catalyst poisons such as arsenic and trace metals are substantially reduced, preventing catalyst contamination.***

TR 5528

For more data on advertised products, use Readers' Service Cards, last page.

As a companion to its line of Type M Unibrake Motors with magnetic braking . . . Master now offers a line of Type D Unibrake Motors with dynamic braking.

HOW IT WORKS. Dynamic braking is obtained with a patented* unique, multi-polar brake winding superimposed on the stator winding of any Master single-phase or polyphase induction motor.

ADVANTAGES. Unibrake motors with dynamic braking are very compact, usually no larger than the standard motor. And since the dynamic brake has no moving parts, there is no wear . . . nothing to adjust . . . braking torque remains uniform.

INCREASE PRODUCTION. Don't waste valuable production time waiting for machinery to coast to a stop . . . get quick slow-down for machine tool spindles . . . quick turn-around time on many operations . . . speed up automatic cycling of machinery. And since Type D Unibrake Motors come to a rolling stop, they are particularly adaptable to equipment requiring gear shift between cycles.

SIZES. Now available up to 30 horsepower . . . larger ratings are being developed. Master Gearmotors and variable speed drives can also be supplied with Type D Unibrakes.

LITERATURE. For complete information write for Data 3810.

Now

DYNAMIC BRAKING

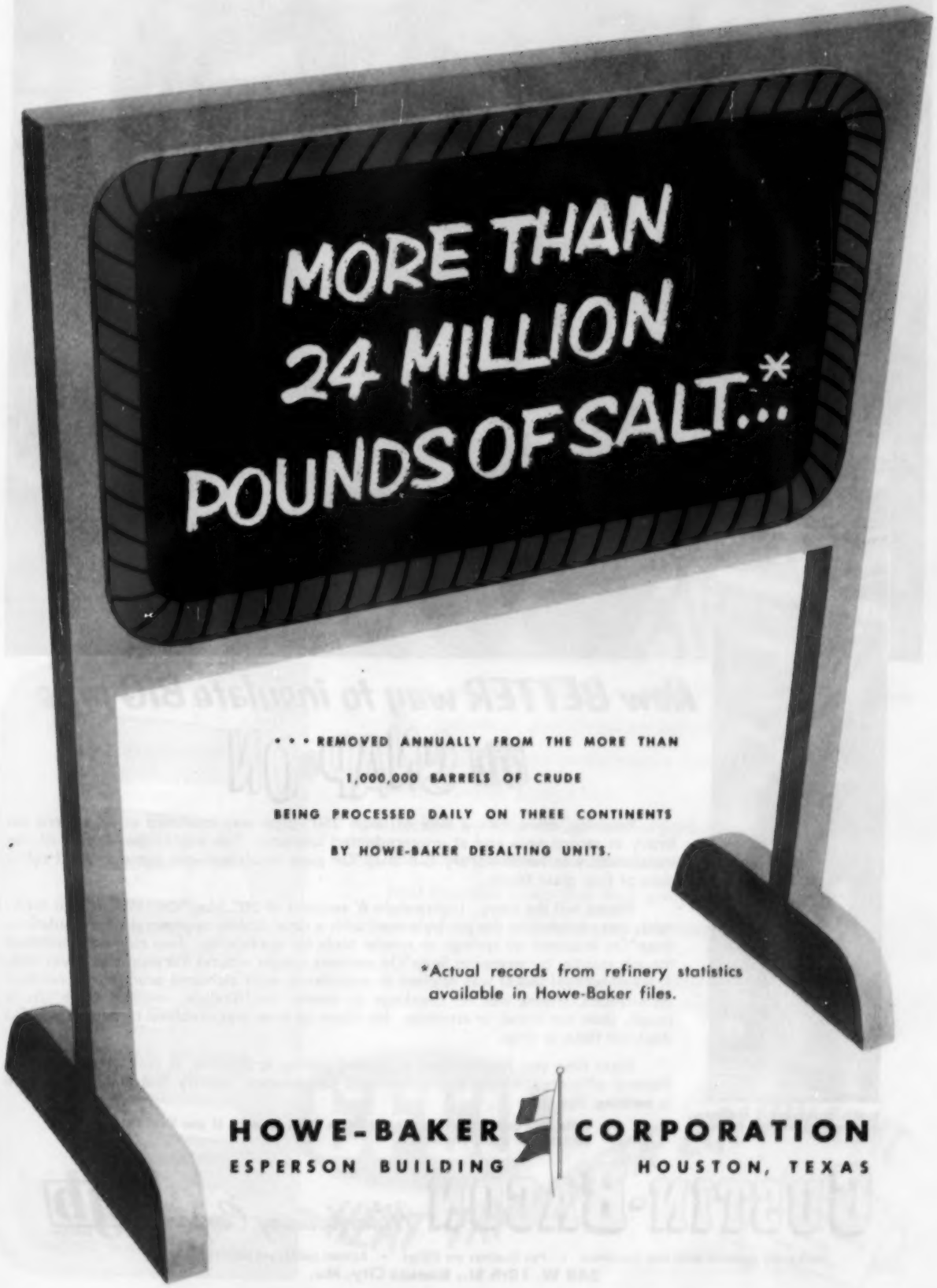
for A-C motors

THE MASTER ELECTRIC COMPANY • DAYTON 1, OHIO

MASTER

UNIBRAKE MOTORS

* U. S. Patent 2,627,059



• • • REMOVED ANNUALLY FROM THE MORE THAN

1,000,000 BARRELS OF CRUDE

BEING PROCESSED DAILY ON THREE CONTINENTS

BY HOWE-BAKER DESALTING UNITS.

*Actual records from refinery statistics available in Howe-Baker files.

HOWE-BAKER CORPORATION

ESPERSON BUILDING HOUSTON, TEXAS

For more data on advertised products, use Readers' Service Cards, last page.

Rugged, lightweight 6' sections are amazingly easy to handle.

New BETTER way to insulate BIG pipe

GUSTIN-BACON SNAP*ON

Recently, more than a mile of large 250° pipe was insulated at an eastern refinery in record time and at unprecedented low cost. The key to the success of the installation was revolutionary G-B Snap*On pipe insulation—one-piece molded cylinders of fine glass fibers.

Photos tell the story. Lightweight 6' sections of 20" Snap*On, 1½" in wall thickness, were hoisted to the job by a man with a rope. Unlike segmental pipe insulation, Snap*On required no springs or special tools for application. Two men accomplished the job quickly by snapping Snap*On sections snugly around the pipe and tracer line. A weatherproof jacket was applied in accordance with standard practice for outdoor installations. There was no breakage or waste, for flexible, resilient Snap*On is tough, does not break or crumble. No clean-up time was involved because Snap*On does not flake or chip.

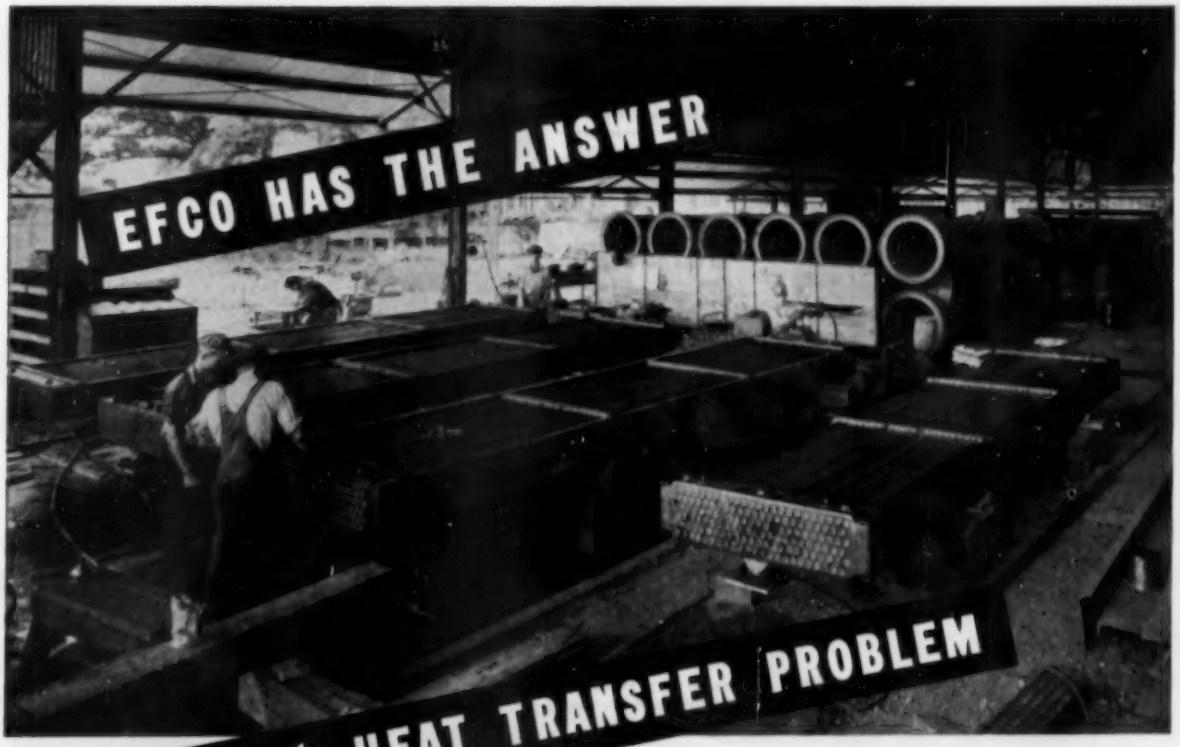
Next time you have chilled or heated piping to insulate, if you want maximum thermal efficiency, easier application and permanence, specify G-B Snap*On. There is **nothing** like it!

Write for 8-page brochure or see the Yellow Pages for name of your local distributor who carries local stocks of Snap*On.

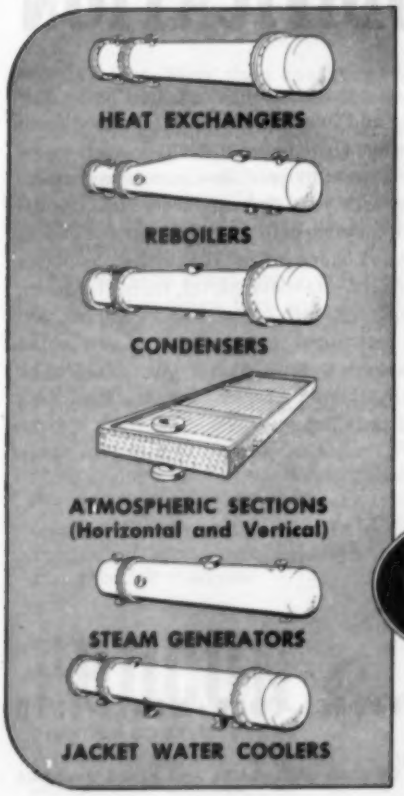
GUSTIN-BACON *Manufacturing Company*

Thermal and acoustical glass fiber insulations • Pipe Couplings and fittings • Railroad gaskets and supplies

242 W. 10th St., Kansas City, Mo.



TO *your* HEAT TRANSFER PROBLEM



● If your problem is the poor performance or high maintenance cost of your heat transfer units, consult an EFCO engineer. He will help you decide the changes or modifications necessary to get the desired performance from your heat transfer equipment.

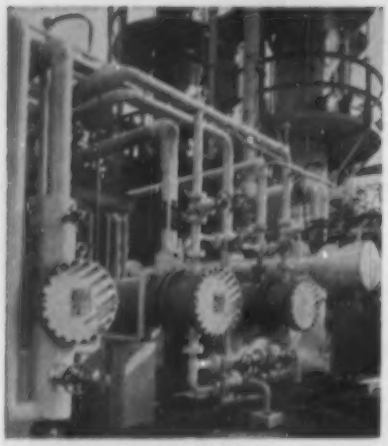
Backed by knowledge and experience, EFCO engineers are constantly working to produce heat transfer units that will give efficient performance and long, trouble-free operation.

ENGINEERS & FABRICATORS, INC.
P. O. Box 7395 Houston 8, Texas

EFCO

HEAT TRANSFER EQUIPMENT

For more data on advertised products, use Readers' Service Cards, last page.



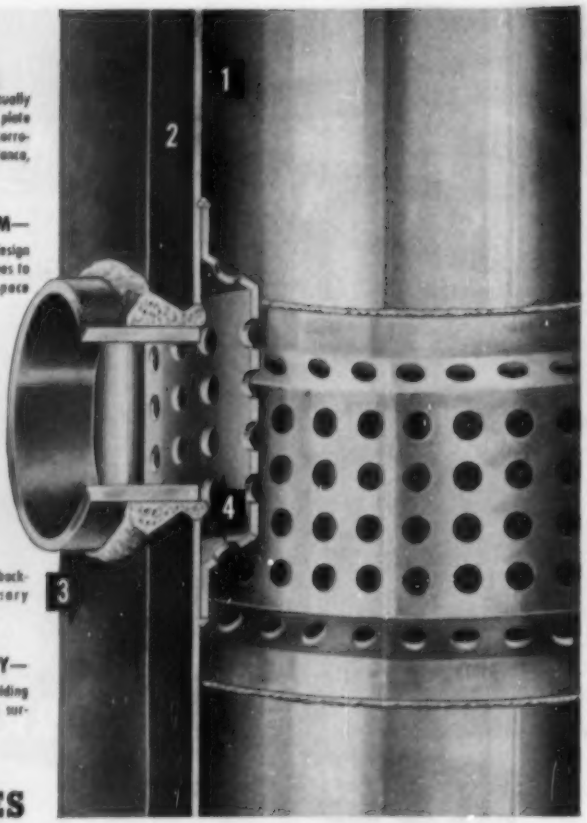
Stainless-clad steel checks corrosion in these acid stripping and cooling units handling naphthenic acid at 350° F.

1 ECONOMY—
High alloy layer—usually 10% or 20% of total plate thickness — assures corrosion and abrasion resistance, long equipment life.

2 DESIGN FREEDOM—
Integral bond allows design and fabrication of shapes to meet process and space needs.

3 STRUCTURAL STABILITY—
Low-cost carbon steel backing provides necessary strength and rigidity.

4 EASY TO MODIFY—
Normal cutting and welding will not endanger clad surface or bond.



CLAD STEEL EQUIPMENT ASSURES

LONG LIFE AND EASY MODIFICATION

To help you lengthen profitable service life *and* overcome the factor of high first cost, clad steel equipment offers two unique advantages. First, clad steel construction permits easy tank and pressure vessel revision when new openings must be cut and flanges or pipes welded on. The bond between cladding and backing is not affected by the temperature range where clad can be applied. This eliminates seepage and crevice corrosion.

Second, you get all the benefits of solid high alloy's corrosion resistance and protection with savings up to 50% in material costs. Because cladding and backing are bonded over their entire surface, the API-ASME Code permits full gage consideration for design purposes.

Long service life and low cost protection, plus other advantages such as economical field erection and easier drainage, cleaning and inspection, can be obtained from 16 cladding materials. *Qualified* equipment builders know best how to apply these to your new processing equipment. By working with your own engineers and consultants from the start, they can help you get longer equipment life at lower cost. Lukens offers the widest available selection of clad steels—stainless, nickel, Inconel, Monel, copper—and cooperates with fabricators in helping you to select the type best suited to your needs. If you would like more information, consult one of your builders or write Manager, Marketing Service, Lukens Steel Co., 752 Lukens Building, Coatesville, Pa.

LUKENS CLAD STEELS

STAINLESS-CLAD · NICKEL-CLAD · INCONEL-CLAD · MONEL-CLAD

PRODUCER OF THE WIDEST RANGE OF TYPES AND SIZES OF CLAD STEEL PLATES AND HEADS AVAILABLE

For more data on advertised products, use Readers' Service Cards, last page.

three heads are not necessarily better than one

It's a fact. More than one head can very well lead to confusion, delusion and costly conclusions.

Petroleum refiners, in particular, have found this to be true after placing their multiplant expansion programs in the hands of several different process construction organizations. Believing this would result in greater efficiencies, they discovered too late that such an arrangement was creating—not —solving problems.

This potential pitfall was avoided by Quaker State Oil Refining Corporation when they selected Procon for the expansion of their three refineries. For Quaker State this meant working with one organization . . . having one organization responsible for the completion of all three projects.

Procon's work for Quaker State included the erection of three UOP Platforming units. A 1,500 barrel-per-stream day unit was installed at Farmer's Valley, Pa., while 1,000 barrel-per-stream day units were constructed at Emlenton, Pa. and at St. Marys, W. Va.

Quaker State's satisfaction in the three jobs completed for them by Procon is proof enough that three heads aren't necessarily better than one.

Farmer's Valley, Pa.

Emlenton, Pa.

St. Marys, W. Va.

PROCON *Incorporated*

PROCESS CONSTRUCTION

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for Refinery Corrosion Control

INJECT *Visco*® AHEAD OF TROUBLE

Sure Sign of EFFICIENT Corrosion Protection

Injection of Visco Anti-Corrosion Chemicals ahead of trouble spots in refinery lines and equipment is a sound, low-cost prescription for effective corrosion control. This is the way Visco Anti-Corrosion Chemicals work: They form a tough, monomolecular film on metal surfaces by adsorption to the metal. The film is highly resistant to corrosive gases and liquids encountered in refining, and is maintained by small dosages at intervals, or in proportion to throughput rates. Other important characteristics include high temperature stability, no emulsion-forming tendencies, and no catalyst poisoning or color effects on finished products.

Detailed data on Visco Anti-Corrosion Chemicals for your applications will be sent promptly upon request. Write today.

VISCO PRODUCTS COMPANY
INCORPORATED
2600 Nottingham at Kirby
Houston 5, Texas • Telephone MAdison 0433

Proof of Corrosion Control

One method of obtaining data on corrosion rates consists of accurately weighing small metal coupons before and after placement in process lines. Your Visco Representative can help you select a means of proving the effectiveness of Visco corrosion control in your equipment . . . with no obligation to you. Write or phone for action now.

Visco **CONSISTENTLY EFFICIENT OIL INDUSTRY CHEMICALS**

For more data on advertised products, use Readers' Service Cards, last page.

THE MOST POWERFUL GASOLINE LOSES ITS POWER WITHOUT THESE ADDITIVES

Tenamene

EASTMAN GASOLINE ADDITIVES

Protecting the performance of gasoline are the gum-inhibiting Tenamenes. Protecting the performance of the Tenamenes are the care in manufacture and the interested technical service of our petroleum specialists who are ready to help solve your refinery inhibitor problems on the spot.

For more information on Tenamene additives and the service that backs up their proper use, contact our local representative or write to Eastman Chemical Products, Inc., Kingsport, Tennessee—a subsidiary of Eastman Kodak Company.

SALES OFFICES: Eastman Chemical Products, Inc., Kingsport, Tennessee; New York—260 Madison Ave.; Framingham, Mass.—65 Concord St.; Cincinnati—Carew Tower; Cleveland—Terminal Tower Bldg.; Chicago—360 N. Michigan Ave.; St. Louis—Continental Bldg.; Houston—412 Main St. **West Coast: Wilson Meyer Co.,** San Francisco—333 Montgomery St.; Los Angeles—4800 District Blvd.; Portland—520 S. W. Sixth Ave.; Salt Lake City—73 S. Main St.; Seattle—821 Second Ave.

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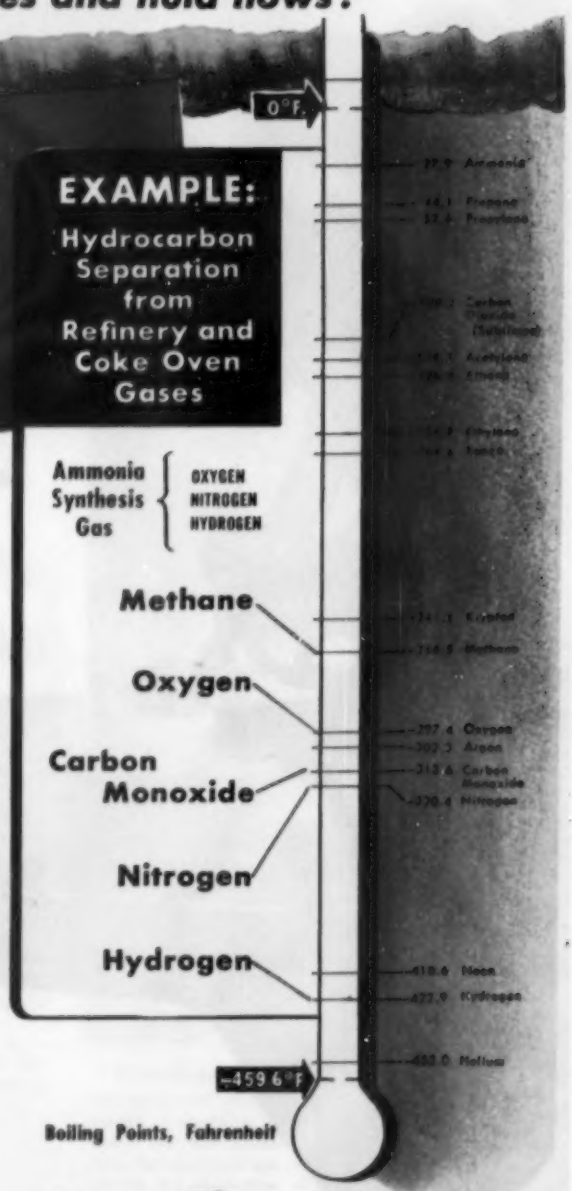
NEW REVENUES

from by-product gases and fluid flows?

LOW-TEMPERATURE PROCESSING

can realize potential profits

EXAMPLE:
Hydrocarbon Separation from Refinery and Coke Oven Gases



LOW-TEMPERATURE liquefaction and separation of gases causes many waste gases and fluid flows to yield valuable products. This interesting technology, in fact, reveals bright new horizons of profit for the chemical, petroleum, steel and other process industries. By its means not only is it practicable to recover useful elements that cannot be reclaimed otherwise, but even where other methods are feasible, a low-temperature system often does a superior recovery process.

Air Products, Incorporated, has been prominent in this field for many years. The company has designed and built more than 700 low-temperature gas separation plants for many of the largest companies in the world. Over 100 graduate engineers employed full-time by this company, are at your service. They will study your possibilities for using low-temperature processing profitably, providing a preliminary engineering analysis or a complete process design. Send us an outline of your problem—there is no charge for preliminary consultation. *Air Products, Inc., Dept. X, Box 538, Allentown, Pa.*

36-page BROCHURE explores the broad possibilities of low-temperature processing Write for a free copy.

Air Products
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Specialists in Low-Temperature Processing

Cost Analyses • Process Design • Apparatus Design • Apparatus Manufacture

The Mail Box . . .

Question Source Of Chemical Figures

To the Editor:

In Table 1 on page 131 of the December, 1954, issue of the PETROLEUM REFINER in the column headed "Production 1953 United States Tariff Commission Report" there is shown the figure of 135 million pounds of polyethylene, but when I wrote to the United States Tariff Commission asking for a copy of the report showing this polyethylene figure, they replied that this figure was not obtained from any Tariff Commission publication. Evidently, therefore, some mistake has been made and I shall be grateful if you will quote the source of this figure.

J. F. Oliver
Central Information Service
of the Industrial Group
THE DISTILLERS
COMPANY LIMITED
London, England

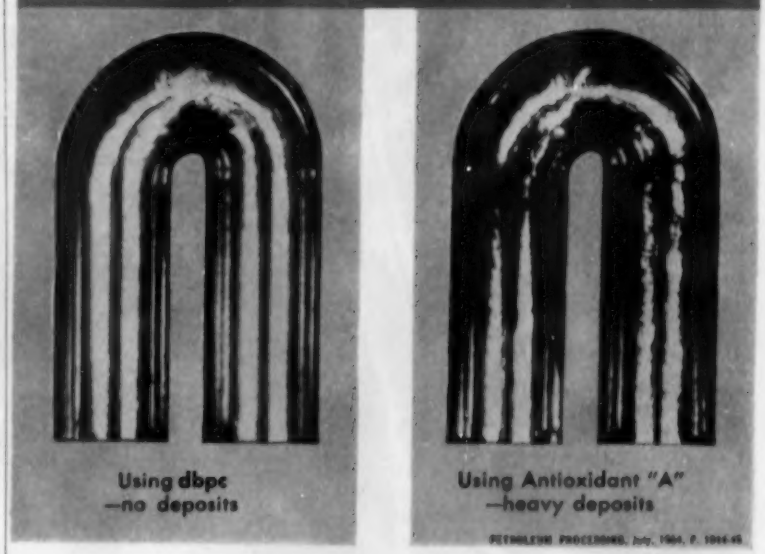
To the Editor:

While most of the figures credited in your December, 1954, issue by Raphael Katzen to the Tariff Commission in the chart on page 131 are correct, we do not know the source of the 135 million pounds for U. S. polyethylene production. This figure was not obtained from any Tariff Commission publication as data on production of the polyethylene in 1953 were accepted in confidence, and they may not be published as their release would reveal the operations of individual companies. Statistics on ammonia are not published by the Tariff Commission; they are compiled by the Bureau of the Census, U. S. Department of Commerce.

Also, the Tariff Commission did not publish production statistics on acetaldehyde for 1953; therefore, the figure of 800 million pounds given in the table may not be properly credited to us. Also, the figure of 1475 million pounds for ethanol production in 1953 was not obtained from a Tariff Commission publication. We publish data on synthetic ethanol only. Production of this material in 1953 was 1060 million pounds. Data on fermentation alcohol are reported by the Internal Revenue Service.

It would be appreciated if you

HERE'S PROOF!—



dbpc® Antioxidant

does not contribute to manifold deposits

Two popular antioxidants—**dbpc** inhibitor* and a well-known commercial gasoline gum inhibitor — were tested in a blend containing 60% catalytic cracked and 40% thermal cracked gasolines. The manifold test unit employed in the experiment consisted of the specially-designed manifold shown here, attached to a single-cylinder, air-cooled engine, with provisions for control of fuel rate and temperature. The air-fuel mixture from the carburetor entered the manifold which was heated by two 500-watt, pancake electric heaters attached to the manifold exterior. Manifold temperature averaged 255° F. Photographs above show identical sections of the two test manifolds.

Operational tests were made on both antioxidants and the results showed that **dbpc** did not contribute to manifold deposits. (Left photo). On the contrary, it actually tended to *reduce* deposits. Antioxidant "A," on the other hand, *increased* manifold deposits, as shown in the right hand photograph.

In addition to this outstanding feature, **dbpc,** *pound for pound, is the most economical gasoline antioxidant in use today.*

dbpc is also supplied in easy-to-handle liquid form as Impruvol 33® antioxidant. For information write:

*2, 6 di-tert-butyl-para-cresol

KOPPERS COMPANY, INC.
Chemical Division, Dept. PR-45, Pittsburgh 19, Pennsylvania

KOPPERS®
Koppers Chemicals
SALES OFFICES: NEW YORK · BOSTON · PHILADELPHIA · ATLANTA
CHICAGO · DETROIT · LOS ANGELES · HOUSTON

For more data on advertised products, use Readers' Service Cards, last page.

This is what dockmen call flexibility in a hose...

It's a hook-up of U. S. Rubber's H-1515

Notice the snakelike, flexible way this 12" I. D. hose drapes over and around objects on this oil-barge dock. This is one hose that's not bulky, heavy or stiff. It's a dockworker's dream of a hose.

Known as Amazon® H-1515, this United States Rubber Company hose is 2/3 lighter than conventional hose. It is so flexible and easy-to-handle that it sharply reduces make-up time to the header. And naturally, this light weight and extra flexibility reduce accidents. As for durability, U. S. Amazon, despite its light weight, takes rough treatment without damage. *It's in a class by itself.* Its ease of handling, quick make-up time *reduce loading charges.*

U. S. Amazon has been thoroughly proven by five years of Navy service and four years of oil company service. It is now used by every major oil company in America and most foreign countries. Made only by United States Rubber Company and sold through any of the 27 "U. S." District Sales Offices. For more information write address below.

US RUBBER

"U.S." Research perfects it..."U.S." Production builds it... U.S. Industry depends on it!

UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION • ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting

The Mail Box . . .

would call the matter to the attention of Mr. Katzen, and, if possible, amend the record in an early issue of your publication.

Donn N. Bent
Secretary
United States Tariff Commission
Washington 25, D. C.

Author Replies

In my original accumulation of 1953 production data and estimates for my December, 1954, article, I had set up one column for U. S. Tariff Commission data and another for data from other sources. As I was finishing the article, I decided to simplify the table by putting all 1953 production data in one column. This should have been headed "U. S. Tariff Commission Report and Other Sources." I indicated that this data was from more than one source in the text (page 128, paragraph 4, second sentence) when I referred to the table as follows: "Also listed are 1953 production figures taken *primarily* from U. S. Tariff Commission Reports, and 1954 production estimates." As a result, three of the 24 items listed under 1953 production were not covered in the U. S. T. C. report, and a fourth item was covered only in part.

The actual sources of the data and estimates for these items were as follows:

1. **Polyethylene**—Since there were only two major producers in 1953, exact production data were not available. An estimate of this production was made in chart form in *Business Week*, May 9, 1953, p. 41. The text does not elaborate on the chart.

2. **Ammonia**—These data were available from several sources such as the U. S. Department of Commerce Bureau of Census reports referred to by Mr. Bent. A summary chart of production of synthetic ammonia over several years, was published by *Chemical Week*, August 14, 1954, p. 73. This showed about 4500 million pounds synthetic ammonia production in 1953. To this I added an estimate for by-product ammonia production of 300 million pounds and obtained the total of 4800 million pounds.

3. **Acetaldehyde**—Data were from two sources—*Chemical Week*, October 9, 1954, p. 93, which indicated 700 million pound per year production and *Chemical and Engineering News*, July 12, 1954, p. 2836, in which the following sentence appears "Acetaldehyde supply amounted to about 725 million pounds in 1951, since has risen to close to 800 million pounds." In view of private information which I had on expanded capacity of acetaldehyde facilities in 1951 and 1952, and the indication that these had been operated close to capacity in 1953, I gave credence to the higher

For better small tube maintenance
ELLIOTT
TUBE CLEANERS
and EXPANDERS
NEW ELLIOTT TUBE GAGE
Measures inside tube diameters in .001". A quick, guide for setting tube expanders for condenser and heat exchanger tubes. Three point contact of hardened steel balls insures accurate measurements.
ELLIOTT TUBE EXPANDERS
Roll condenser and heat exchanger tubes quickly and accurately. Rotating, parallel self-feeding rolls insure good joints. For tubes ¼ in. through 1½ in.
ELLIOTT CONDENSER CLEANER
Direct-drive air-driven cleaner using shaft and drill heads. Motor supported outside the tube by overhead pipe. Also available with electric motor.
ELLIOTT JIFFY GUN
Shoots nylon or rubber plugs through small tubes for rapid cleaning. Operated by inserting nozzle into tube end and pushing.
ELLIOTT 600 Series Cleaners
For straight and curved small tubes. Air or steam driven motors. Can be equipped with expanding brushes and scraper heads.
Y4-16
Write for Descriptive Bulletin Y-38
Address Elliott Company, Legonda Division, Springfield, Ohio
ELLIOTT Company

For more data on advertised products, use Readers' Service Cards, last page.

Bingham STUFFINGBOXLESS PUMPS

HANDLE LIGHT HYDROCARBONS* AT HIGH SUCTION PRESSURES

NO STUFFING BOX! NO PACKING!

Bingham Stuffingboxless Pumps are successfully handling liquids having high vapor pressure, requiring high suction pressure and, frequently, abnormally low pumping temperature (—300°).

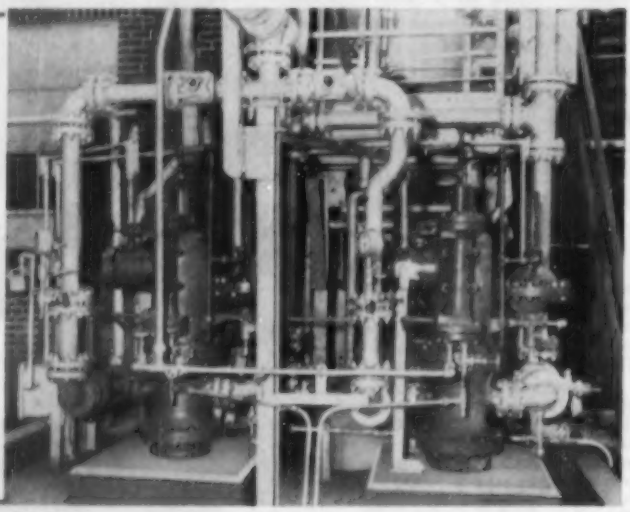
Standard models handle suction pressures up to 2,000 psi (higher pressures available). Pumping temperatures to 850° F. and higher also can be handled.

Bingham Stuffingboxless Pumps are in service today all over the world, with distinguished records in reliability, continuity of service, and low maintenance. Write to your nearest Bingham office for Bulletin 107 or for additional information.

*And other volatile liquids.

BINGHAM STUFFINGBOXLESS PUMPS OFFER:

- Lower overall installed cost
- Less operating attendance
- No misalignment of moving parts
- Smooth operation
- No auxiliary lubricating system
- No exposed moving parts
- Positive motor cooling
- All parts are accessible



FIREPROOF AND EXPLOSION-PROOF! Leakage of vapor to atmosphere or leakage from outside into pump is impossible. Not only is plant and personnel protected, but loss of valuable pumpage is prevented. Type KT Multi-Stage Stuffingboxless Pump illustrated.

Bingham Type KT Stuffingboxless Pumps handling liquid propane under high suction pressure at Esso Standard Oil Company refinery, Bayway, New Jersey.

Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY

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The Mail Box . . .

production figure of 800 million pounds.

4. **Ethanol**—The figure of 1060 million pounds for synthetic ethanol was from the U. S. T. C. report. Then I checked information on molasses end-use to determine industrial alcohol production from this source. I also added the production of the one sulfite waste liquor alcohol plant. These yielded the total of 1475 million pounds.

In Table 1, last column, the estimated 1955 capacity for synthetic rubber should be 2100 million pounds, not 4200 million pounds.

Will you please set the record straight by publishing these corrections?

Raphael Katzen
Cincinnati, Ohio

Reprints Help Work

To the Editor:

Several months ago you were good enough to send us a copy of a one-page reprint from the PETROLEUM REFINER, October, 1953, bearing the title of *The Problem of Alcoholism in Industry.* This article, written by Dr. Bryce B. Reeve, Director of Medical Department of Standard Oil Company (Indiana) can be very useful in our educational work in this field.

Therefore, we write at this time to ask about 1000 reprints . . . which would further our educational advances in this work.

Yvelin Gardner,
Associate Director
The National Committee on
Alcoholism, Inc., New York

Editor's Note—The reprints sought will be made available. This is another "As Management Sees It" article which seems to have rung the bell.

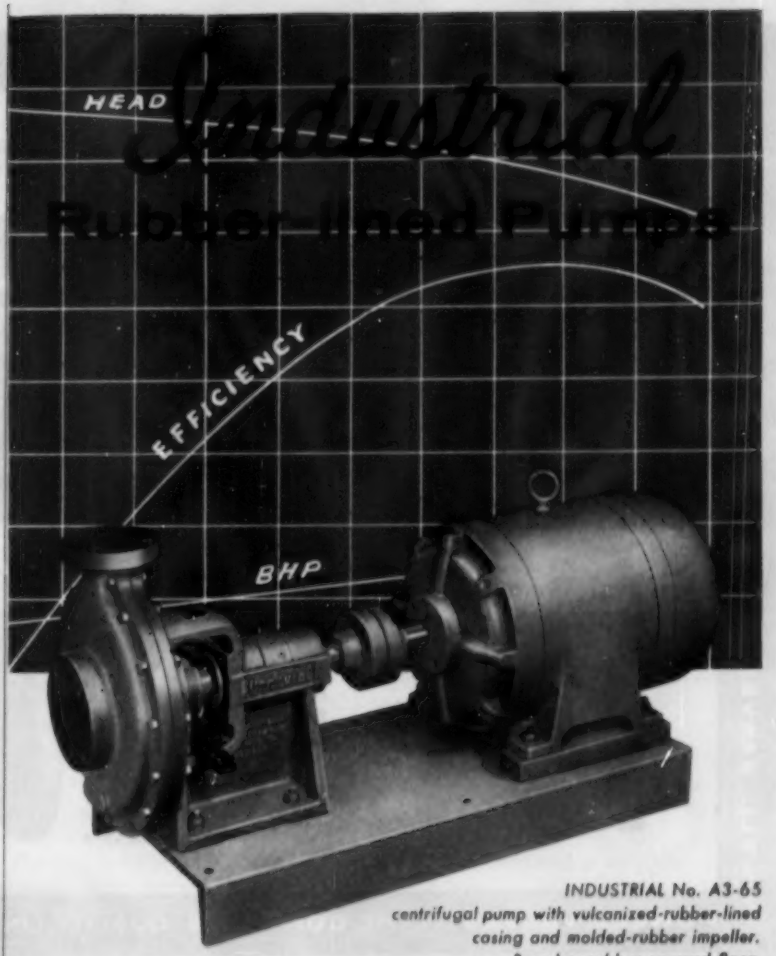
Helpful, Meaty

To The Editor:

I have the two copies of the August REFINER. The issue contains three of the most helpful, meaty, worthwhile articles that I have had the pleasure of reading. I have kept one for my own file and I circulated the other copy.

May 1955 bring great success and lucky leads to you.

Eugene L. Price, Editor
The Beacon
The Ohio Oil Company,
Finlay, Ohio



Industrial
Rubber-lined Pumps

INDUSTRIAL No. A3-65
centrifugal pump with vulcanized-rubber-lined casing and molded-rubber impeller. Base has rubber-covered floor.

for corrosive and noncorrosive liquids

The latest in pump engineering and design is incorporated in INDUSTRIAL centrifugal pumps for maximum efficiency and severe, continuous service. Lined with soft rubber for abrasive slurries or hard rubber as specified, balanced rotating assembly mounted in ball bearings, corrosion-proof stuffing box to permit external liquid seal if required, easily removable packing gland nut and ample space for repacking stuffing box, simple adjustment of impeller clearance are some of the features.

These pumps are made in a range of sizes with capacities up to 240 gpm., operating heads up to 240 feet, and ¾ to 15 hp. They are furnished either with or without base, motor, and coupling

Complete Information on Request 5150

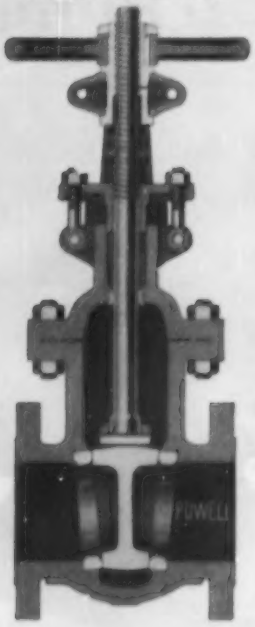
INDUSTRIAL
FILTER & PUMP MFG. CO.
5924 Ogden Avenue • Chicago 50, Illinois

PRESSURE FILTERS
ION EXCHANGERS
RUBBER LININGS
HEAT EXCHANGERS
CENTRIFUGAL PUMPS

For more data on advertised products, use Readers' Service Cards, last page.

POWELL VALVES ... THE COMPLETE QUALITY LINE ... POWELL VALVES

FIG. 1503 (Sectional)—
150-Pound Steel Gate Valve.



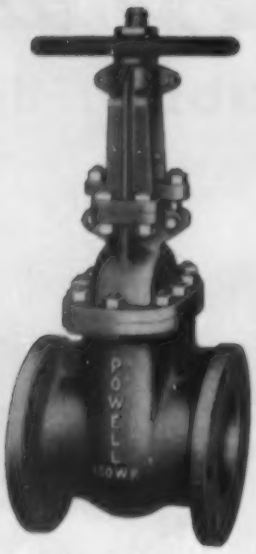


FIG. 2453-G—Stainless
Steel O.S. & Y. Gate Valve
For 150 Pounds.

FIG. 3059-G—300-Pound Steel
Lubricated Plug Valve. Gear Operated

FIG. 3061—300-Pound
Steel Swing Check Valve.

POWELL VALVES ... THE COMPLETE QUALITY LINE ... POWELL VALVES

THE COMPLETE QUALITY LINE ... POWELL VALVES ... THE COMPLETE QUALITY LINE ...

Why Petroleum Engineers Specify Powell Valves . . .

. . . . *because they know Powell Valves are dependable and economical.* Petroleum engineers also know that Powell has *the COMPLETE quality line of valves.*

Investigate the many outstanding features of the Powell Valves shown here . . . as well as *the complete line* of quality valves that have a proven record of long life and dependable service.

Consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our complete line, and help solve any flow control problem you may have.

The Wm. Powell Company, Cincinnati 22, Ohio . . . . . 109th year

POWELL VALVES

A Quick Look at the Industry THIS MONTH

Petroleum REFINER
April, 1955

Most industry engineers will be no more vulnerable to draft than before oil was dropped from government list of essential activities. Draft board officials say deferments will depend on (1) how necessary an engineer is to his company, and (2) manpower quota of his draft board. Non-technical employes will generally be less eligible for deferment henceforth.

-•-

Oil's outlay for new manufacturing facilities will climb 3 percent in 1955. This is estimate of Securities & Exchange Commission, which puts year's investment at $2765 million, or $81 million more than 1954's $2684 million.

Fantastic spending necessary to keeping abreast of fast-developing petroleum industry is told in report of Standard Oil Company (Indiana). In single decade this company has put $1850 million into capital expenditures. This is 10-year outlay of $500,000 per day.

These figures foretell tremendous expenditures in years to come, for replacement must ultimately follow expansion as equipment becomes obsolete or wears out. Companion statistic is $10 billion machinery replacement need anticipated for all industries this year by Machinery & Allied Products Institute. Machines for expansion, says Institute, will run $11 billion. But decade hence, capital outlay for plants, replacement, expansion will be $40 billion, may reach $50 billion if growth rate exceeds 3 percent annually.

-•-

Floating weather stations in Gulf of Mexico are proposed in new Congressional legislation. Need for such radar-equipped ships to erase blind spots in short-based radar network has long been recognized by coastal experts as well as Weather Bureau itself, which has been hampered by limited budget.

-•-

Round of expansion in butadiene plants will follow approval of synthetic rubber plants sale. Units would be for converting plants to butane instead of butylene feedstock, and for utilizing by-product streams. Butylenes are increasingly valuable as feed to alkylation units for high octane gasoline components. Installation of butane dehydrogenation facilities would free some of butylenes for this purpose and would permit use of easy-to-get butane.

Development of by-product streams may be opened up under private ownership, now that installation will not put government into competition with industry.

-•-

Look for another flood of catalytic reforming process designs. With 100 octane premium gasoline in sight, processes will feature production of 100-octane clear super-gasoline. Two (Rexforming and Iso-Plus) have already been announced. **But don't expect premium gasoline to level off at 100 octane.** It will go well over 100, auto-makers predict.

-•-

Pay raise for chemical workers will be early goal of new Oil, Chemical and Atomic Workers International Union-CIO. This was consensus of several veteran industrial relations experts after Cleveland wedding of 93,000-member Oil Workers International to 75,000-member United Gas, Coke and Chemical Workers of America.

Chemical wage is about 21 cents under hourly rate of refinery workers. Since recent 10-cent hike latter are averaging $2.44 in these Gulf Coast refineries: Gulf, Texas,

A Quick Look at the Industry (continued)

Magnolia, Pure, Pan-American, Humble, Esso. Moreover, CIO expects to nudge this figure another notch before year's end. Recent agreements left door ajar for more pay talks in '55.

Organization campaign accompanying chemicals pay drive will be closely watched by management in all U. S. industries. Procedure may offer blueprint of what to expect when AFL and CIO finally merge. CIO's basic idea is to organize all workers in an industry into single union. AFL puts skilled workers into separate unions according to crafts. Which philosophy will dominate?

—•—

Auto workers' fight for guaranteed annual wage will affect many industries. Outcome will immediately influence labor relations of others with seasonal production patterns, like steel. Economic impact will be felt by related industries, like petroleum.

Here's how it works: Auto industry is toiling to new production high. More than 1.5 million cars were sold in first quarter, increase of more than one-third above 1954 period. As U. S. Chamber of Commerce noted, demand for GAW may further stimulate new car output. Strike talk will boost sales. Travel—and petroleum use—will thus take another jump. Intercity travel is already increasing 7 percent annually, more than 4½ times rate of population growth. Interstate Commerce Commission estimate for 1954 intercity travel in U. S. is 590 billion passenger miles, of which autos accounted for 80 percent or 500 billion miles.

—•—

Mexico continues its efforts for self-sufficiency in petroleum products. Latest addition to government-owned refining facilities is lubricating oil and wax plants at Salamanca.

Result: $15 million annual cut in imports.

—•—

1955 model engineering graduates may carry highest price tags ever. Demand is brisk as business booms; supply will be limited for several years yet. Result is hotter competition among industry recruiters. Illustrative, though not necessarily typical is situation at Stevens Institute of Technology, Hoboken, N. J.:

170 companies have set up 2000 interviews with 128 graduates—or about 15 each. Average offer is $370 per month, compared with last year's $360, which was record for school. Even those headed for service are being wooed.

—•—

Determining nuclear energy's present and long-term effects on oil industry is object of study made possible by $10,000 grant from Signal Oil & Gas Company. Made to Stanford School of Engineering, grant is believed first of its kind sponsored by an industrial firm.

—•—

Catalytic reforming capacity will amount to 12 percent of U. S. crude charge by January 1, 1956—or 1 million barrels out of 8 million. Reforming is enonomical up to 20 percent of total charge. On this basis, additional expansion of 600,000 barrels per stream day is feasible.

—•—

President's refusal to ask Natural Gas Act amendment brought first dangerous political rift in congressional push of importance to entire petroleum industry. Earlier endorsement of amending legislation by President's Cabinet Fuels Committee brought precipitate opinion that Ike concurred. When he subsequently took non-committal stand, cry arose—unjustly or not—that he was deliberately saddling Democrats with gas consumer states' bitter and inevitable criticism when legislation passes, as still appears likely.

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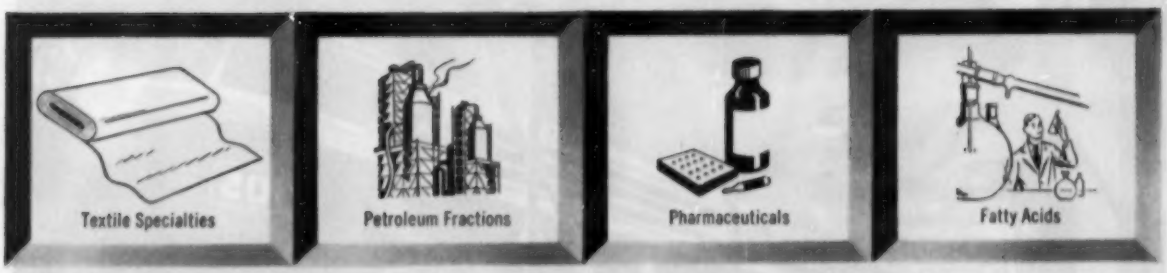

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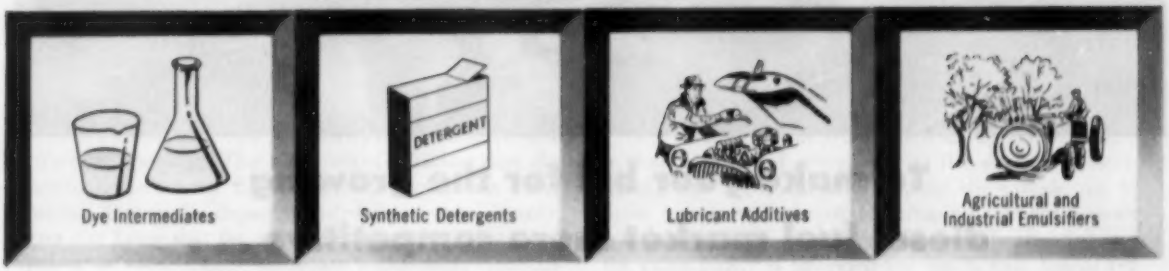

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And Now 100-Octane. What's Our Stake?

IT'S A VICIOUS circle. Starting with the premise that the auto maker is in business to satisfy the consumer, the auto maker finds that the public is impressed with high horsepower engines. Heavy investments are made to produce the cars with impressive engines and big promotion campaigns sell the public on their *need* for a high horsepower engine. The refining industry, also with heavy investments, brings out the necessary fuel for these engines and even goes farther by producing fuels which are just a little better than are neeeded. The auto industry then picks up again to complete the circle—it produces even more impressive engines to use that super-quality gasoline.

What's missing in this circle? There is a lot of information possessed by the auto and refining industry that the public doesn't have. For example, the refining industry knows that only a minority of cars now require premium gasoline. The auto industry knows that the public doesn't need 200-horsepower engines on every model. The traffic departments of every state, county, and city know that the need in automobiles is not more power or more speed—there are many other qualities which make getting there safer and within the law.

Is the attitude of our industry to be one of letting the public have what they think they want (even though many times we make them think it)? Or should we be somewhat paternalistic and give them what is best for driving conditions today? Should we be spending our promotion money on public good rather than public whim? Here are some facts that need to be considered.

There have been many tests conducted to show how the motorist benefits from high octane gasoline and super-horsepowered cars. However, maximum horsepower can be very misleading, since the maximum of an engine is reached only at a very high engine speed, say, in the neighborhood of 70-100 mph in 1954 cars. These speeds do not at all represent the average conditions of motoring and certainly not the legal conditions. Under *actual* driving conditions, the motorist is now having to buy more gasoline to travel one mile than he did before the octane race began in 1949. In 1948, passenger cars travelled 319,459 million miles using 21,271 million gallons of gasoline. This calculates 15.0 miles to the gallon. In 1953, the motorist averaged only 14.5 miles for every gallon of gasoline he purchased. Though tests and statistics are yet to come on the future engines and octanes, most are agreed that when octanes get up to 100 and compression ratios up to 12-to-1 that the motorist is going to have to sacrifice more fuel economy.

It is not denied that some increase in power in cars is necessary for such extras as power steering, power brakes, air conditioning, etc. However, the jump in horsepower ratings has been far beyond what was necessary for these optional equipment items.

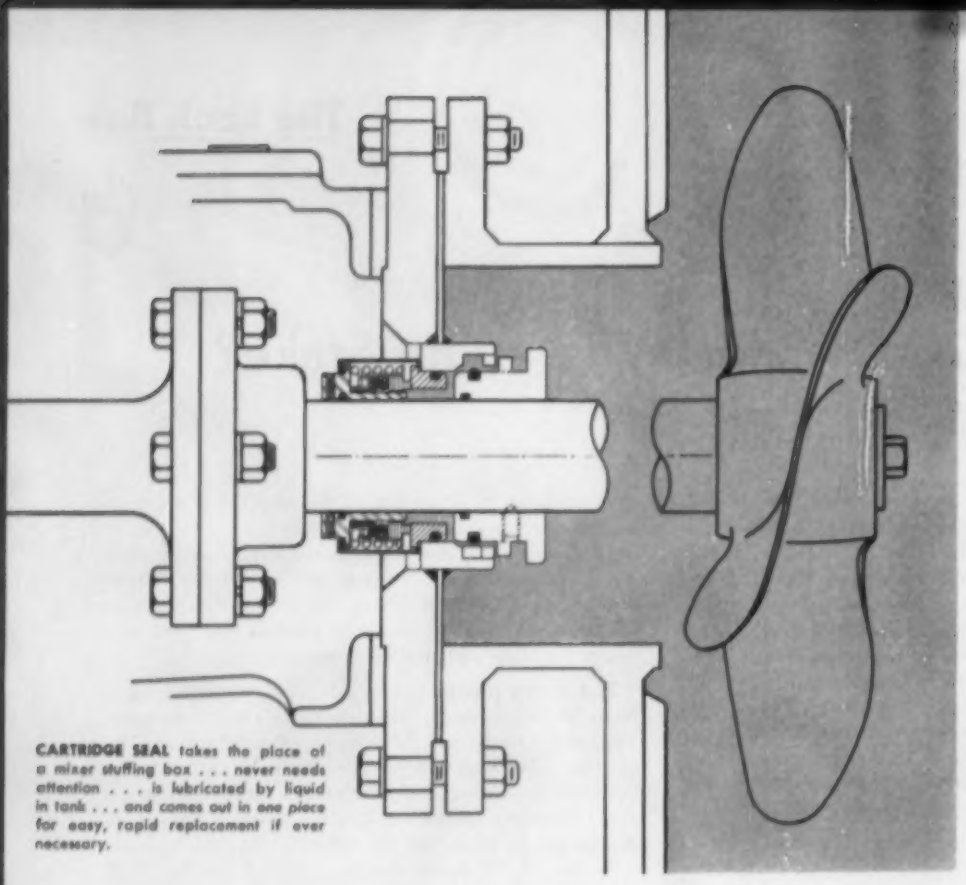
The extra power put in the public's hands doesn't seem to give it much more control over the accident situation. Deaths per 100,000 population rose to 24.1 in 1953. There's one cheery note in this picture—deaths per mile are decreasing. But this is small encouragement when it's considered that the absolute number of deaths stands at 36,300 for the year 1954 (a lot more than the 25,604 battle deaths sustained by the U. S. in the entire Korean War).

One of the least debatable facts about highway safety is that high speed contributes to the severity of accidents. The argument advanced by the proponents of more horsepower are that increasing the horsepower has increased the top speed of cars only slightly, and the extra power is provided for use in case the driver gets himself in a tight spot, and needs a big reserve of power to avoid an accident. This is true as far as it goes but the net result is that most drivers will use this power not only for the tight spots but for just ordinary passing of fast-moving cars. He tends to drive at higher speeds without realizing it and when he does get in a tight spot, he's already used the reserve given him by extra power.

The refining industry has had to spend tremendous sums of money to give the motorist super-quality fuel. Only part of this large investment is now reflected in gasoline prices; but certainly these high-quality products are not going to come free. Gasoline prices since 1948 have risen from 19.54 to 21.59 cents per gallon in 1954 (excluding taxes). With higher octane numbers in sight, no price reduction can be expected and every sign points to an increasing tag on gasoline. The public has no idea what it's paying for increased octanes as price tends to lag behind octane increases. The motorist is also going to pay more for the super-engines as reflected in auto prices. For a more detailed look at the refiner's picture, see the Motor Fuel symposium (page 107) in this issue.

The foregoing considerations are facts the public doesn't know or may not even consider in purchasing cars and gasolines.

And now 100 octane. There will be 300-horsepower



CARTRIDGE SEAL takes the place of a mixer stuffing box . . . never needs attention . . . is lubricated by liquid in tank . . . and comes out in one piece for easy, rapid replacement if ever necessary.

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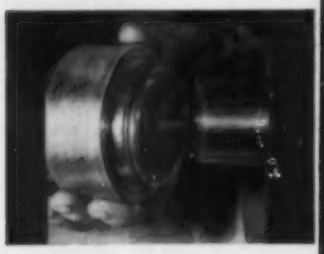

CARTRIDGE SEAL slides off shaft, which uncouples to permit removal. New seal cartridge goes in its place. Taper on shaft insures correct alignment when recoupling.

Mix fluids in big tanks
at lower cost than ever before
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What do you spend yearly to maintain the stuffing boxes on your side entering mixers?

That's a rough measure of what you can *save* by using LIGHTNIN Mixers equipped with new LIGHTNIN cartridge-type rotary mechanical seals.

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You can get LIGHTNIN Seals now on all LIGHTNIN Mixers. You can get quick delivery from stock, any time, on a wide range of seal types, in materials to suit your conditions.

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engines which will be restrained only by present speed limits. There will be new reforming process designs with a considerable sacrifice in yield for high octane. It's a vicious circle.

NACE Is Ten Years Old

WITH THE MANY groups and organizations which are of benefit to the oil industry, it is often easy to overlook the significance of a single organization. One organization which should not be "just taken for granted" is the National Association of Corrosion Engineers.

The present emphasis on reducing maintenance costs calls for increased attention to corrosion control and mitigation. It is comforting to note that here is an organization which through sponsorship of research into the fundamental nature of corrosion, corrosion short courses at many universities, and activities of special committees on corrosion problems, has made and continues to make highly signficant contributions to the body of knowledge of corrosion. All of which is of direct benefit to the refining-petrochemical-natural gasoline industry.

Organized originally in Houston in 1936 as the Mid-Continent Cathodic Protection Association, and incorporated as the NACE in Texas in October, 1945, the organization now numbers more than 4500 members. At the 11th Annual Conference and Exhibition in Chicago last month, some 1500 people from all over the United States and even as far away as Bombay, India, gathered to hear discussions on many corrosion problems. This meeting marks the beginning of the second decade of activity for NACE, and we confidently predict that the next ten years will witness even greater strides in overcoming the problems of corrosion.

Motor Fuel At All-Time Peak

THE INDUSTRY'S economic situation was good at the beginning of the year and continued to be satisfactory through the first two months. However, early March saw this favorable position begin to deteriorate. Refinery output has been at record levels in recent months, and the resulting build up of gasoline stocks now threatens the industry with bulging tanks before this product comes into its heavy-use period.

Early March found motor fuel inventories at an all-time peak, although they had been below the 1954 level at the start of the year. In the first nine weeks of 1955, additions to gasoline stocks amounted to seven million barrels more than were added in the same time of 1954. That left total stocks five million barrels over inventories of a year ago, which, at the time, were higher than desirable. So far this year, gasoline stocks have grown an average of 400,000 barrels daily, compared with 280,000 daily in last year's comparable period.

Unprecedented refining rates have been responsible for the swelling of motor fuel inventories to the point where they promise to become burdensome very soon if operations are continued at current pace. Increased demand for distillate fuel oils encouraged refiners to step up daily thruput to a level of about 400,000 barrels more than was processed daily in the like period of last year. While distillate was being drawn off faster than it was being produced, gasoline was accumulating in large volumes.

Now that the heating oil season is tapering off, reduced refining activity during the relatively low demand period, from now until the start of the motoring season, seems to be indicated.

'Nice Monopoly' —That's Us!

"THE U.S. oil industry is one of the nicer monopolies." This public conception of our industry was revealed once more at the hard core of the progress report delivered by G. Stewart Brown, when he retired some time ago as chairman of the Oil Industry Information Committee.

Thus, if it is conceded, as it must be, that the odious "monopoly" brand is responsible for many of industry's ills, it is apparent that our progress, public relations wise, is in being advanced from "monopoly" to "nice monopoly" in the public's view. Industry is run by a group of giants, but fortunately they are civilized giants who don't starve little children by cutting off the gasoline supply of milk trucks.

Brown reported on the findings of Dr. Claude Robinson, president of Opinion Research Corporation, retained to make an "impartial outside evaluation" of the OIIC program.

Robinson found: "Despite rising criticism of gasoline prices, the over-all favorable impression of the oil industry has risen from 69 to 72 percent between 1946 and 1953."

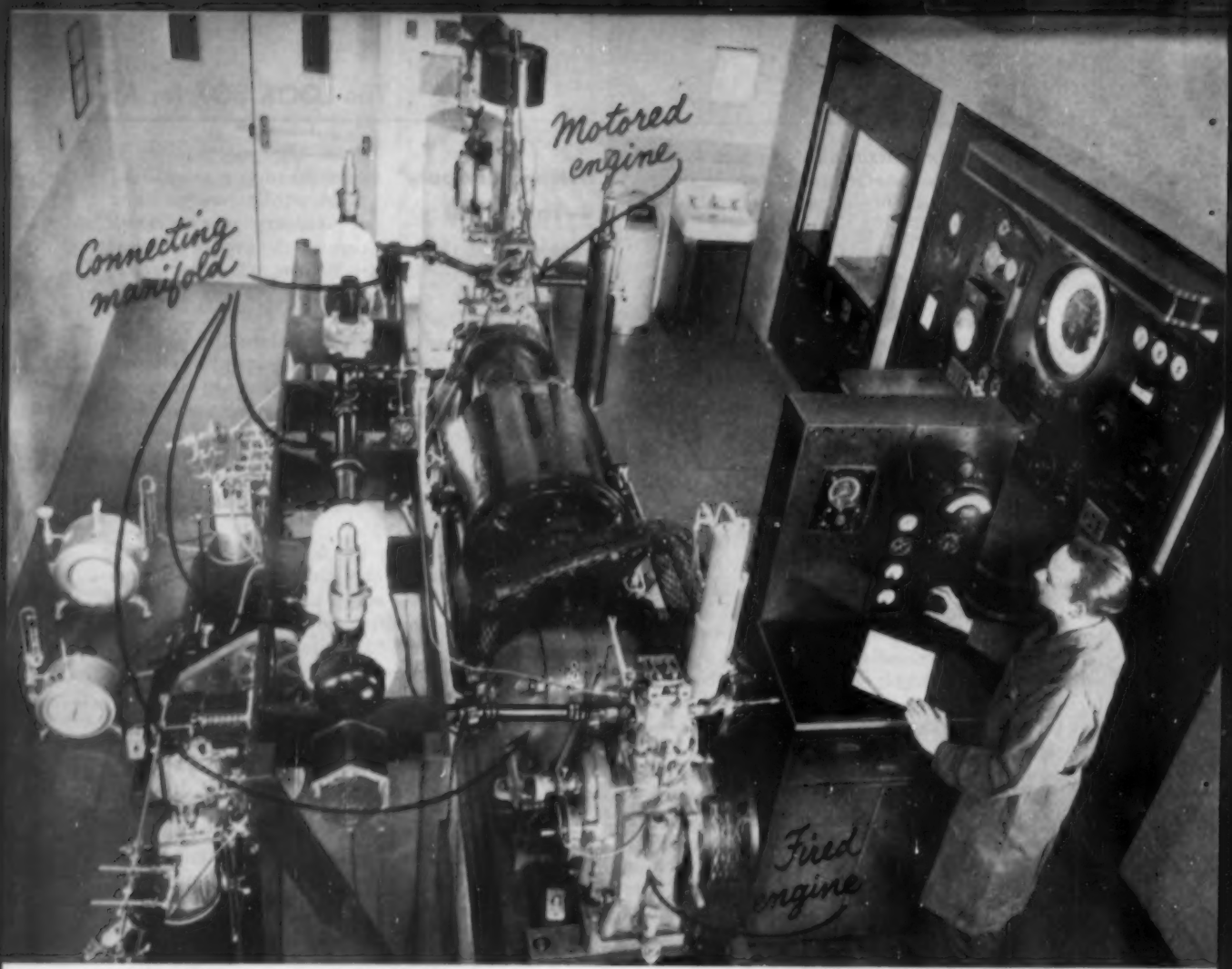
Robinson also found: "The OIIC has succeeded in making the public more conscious of competition in the industry. A large majority, however, still believes that a few big companies dominated the oil industry and that this is not good."

In a frank appraisal that showed a commendable grasp of industry's basic problem, Brown cited three shortcomings in the OIIC effort:

1. The committee has been too modest in asking industry for enough money and manpower.

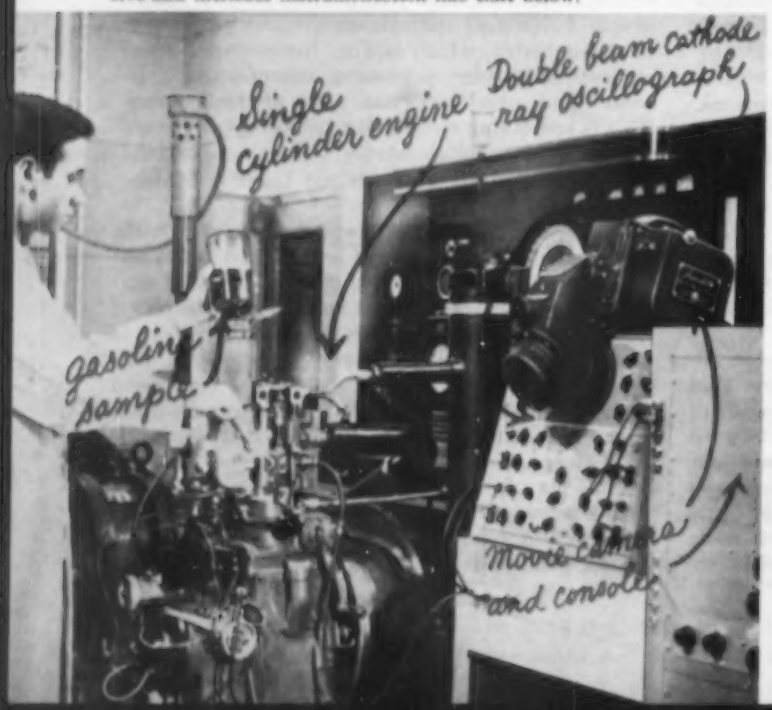
2. OIIC has been using a shotgun to hit all targets instead of a cannon to knock over the big ones.

3. OIIC has been slow to enlist greater participation from more segments of the industry. "Most of our volunteers come from the marketing side of the industry, which is fine. But we need more representation from producing, manufacturnig, research and other important parts of the industry. This is something we intend to work on next year."

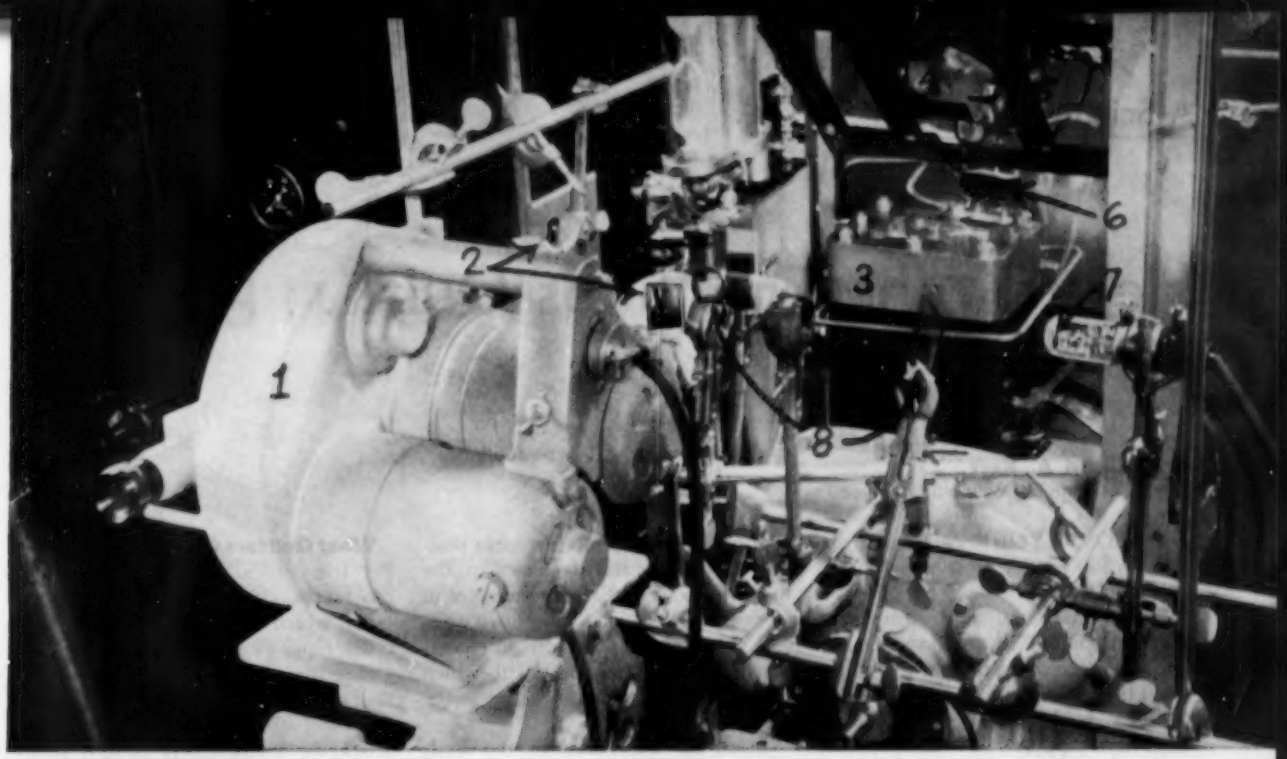


Tandem engine arrangement permits Ethyl Research to produce any desired amount of precombustion reaction by varying compression ratio in a motored engine. The effect of precombustion on knock can then be evaluated in the second engine.

Pressure-time records of modern high-speed engines require expensive and intricate instrumentation like that below.



Direct view of quartz head shows how camera "sees" precombustion reactions.



Complex arrangement of lenses and mirrors permits camera to photograph "cool" flame in engine cylinder utilizing variations in the refractive index of the hot gases. 1. Fastax high-speed movie camera. 2. Mirrors. 3. Cylinder head equipped with quartz window. 4. Mirror showing light reflected from piston top. 5. Synchronizing light. 6. Timing light. 7. Light source—zirconium arc. 8. Optical filters.

Ethyl Research takes a look at precombustion

The instant an air-fuel charge is pulled into the cylinder things begin to happen. The intake valve closes, compression starts—and even before the charge is ignited—important chemical changes take place in the fuel. Just what are these changes? How do they affect the operation of the engine?

Ethyl Research people have been pioneering in this unknown area for years. In their studies they have developed several new techniques, which are helping to fit together the answers.

Among these is a precombustion ("cool" flame) photographic setup using shadowgraph techniques. In this instrumentation a complicated series of lenses and mirrors is arranged so that a high-speed camera capable of 7200 frames a second can photograph "cool" flames in a special test engine. At the same time it picks up flywheel timing marks. A second camera—synchronized with the first—photographs instantaneous pressure traces from the oscilloscope. In this way "cool" flame and pressure records can be precisely correlated.

Another of these special Ethyl instruments is the tandem engine. Here precombustion reactions of different degrees can be made to occur by varying the compression ratio of a motored engine. The reaction products are then rated in a fired engine to find the direct influence of the early reactions on knock.

By analyzing various test results, Ethyl Research has developed a better understanding of precombustion reactions, and thus has added to the general knowledge of the combustion process.

These precombustion studies are an important part of "Ethyl's" basic research program.

ETHYL CORPORATION
Research Laboratories

1600 West Eight Mile Road, Ferndale 20, Michigan
2600 Cajon Road, San Bernardino, California

A Scientist Says:

Here's Why Employes Quit! . . .

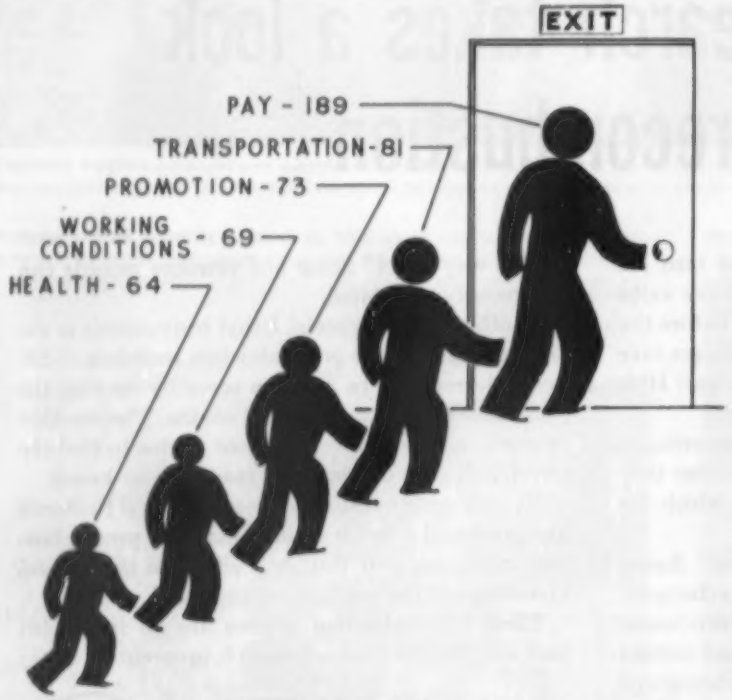
Dr. Willard A. Kerr,
Illinois Institute of Technology, Chicago

IT COSTS YOUR company from $80 to $600 every time an employe quits.

The existence of this turnover is readily apparent on any firm's books; but the causes for the turnovers remain hidden until many tedious hours of research determine that the most important is pay.

The problem was approached by going directly to the "turnovers" themselves and to exit interviewers, who are in a uniquely favorable position to observe the dynamics of the turnover process. Exit interviewers in 48 companies which report 5075 quitting cases yearly cooperated in reporting the relative frequency with which various matters are brought up in the exit interview.

Based on these findings, the study inter-related all the complaints in order to establish typical grievance patterns of quitting personnel.



IT'S NOT SO SIMPLE AS THIS. When asked why they quit their jobs, 189 out of 500 employes said the pay was unsatisfactory, and 81 blamed transportation difficulties. But tedious research revealed some interlocking grievances which indicate that many employes really don't know why they quit.

What Quitters Complain About—Per five typical exit interviews, the pay rate was complained about almost twice, which was more often than any other topic (1.89 times out of 5.00). Other topics, in rank order of mention per five interviews included transportation (0.81), promotion (0.73), working conditions (0.69), poor health (0.64), job security (0.54), friction with co-workers (0.52), poor housing or excessive rents (0.50—that is, once in ten interviews), personal happiness as affected by job experience (0.33), broken promises by supervisor (0.25), confidence in management (0.19), company interest in welfare of employes (0.15), freedom of communication with higher levels (0.12), recreation (0.04), method of wage payment (0.02), other problems (1.15).

Comparison of Exit Complaints—Most of the above topics are included in a widely used job satisfaction survey form employed on non-quitting personnel. When some typical non-quitter data were compared with these exit interview content data, it was found that pay was the foremost grievance in both. Working conditions also was a major grievance in both. Among other topics, however, the agreement was moderate or low.

The results just quoted which emphasize employe concern about pay may seem to contradict some previous evidence. It is true that several researchers have found that when employes are asked what they consider "most important" in their jobs, they *do not* put pay as foremost in impor-

See WHY THEY QUIT, page 106

Employes Say:

. . . And Here's Why They Don't!

Al Reese
REFINER Staff

An employer needs only one qualification to forge an organization of loyal workers.

Authority for that is a group of engineers, superintendents, foremen and miscellaneous workers.

We asked: *"What six things would you most like to see in your employer?"*

They answered: "He doesn't need six qualifications to be a good boss. Just this one: Look upon me as an individual . . . a thinking, feeling being, to be praised if you will, blamed if you must, but never ignored as a machination of nuts and bolts to be set in motion by pressing a button, with no explanation of WHY."

None of the replies were phrased in just those words, but the paraphrasing was unmistakable. The demand to be recognized as an individual, separate and apart from all others, headed virtually every list, and in some cases was reworded again and again. An example is a foreman's list of six things he would most like to see in his employer:

1. Personal interest in each individual as to his welfare.
2. Willingness to see a man get ahead.
3. Heck when we deserve it and likewise a pat on the back when we do a worthwhile job.
4. Tell us their future plans.
5. When changes are made, explain why.
6. A gentleman always worthy of his position.

Related Qualifications—Such was the emphasis upon recognition of each employe as an individual that the other qualifications mentioned could only be interpreted as suggestions for exercising the all-important attribute. These suggestions fell into five broad categories.

- Good communications.
- Proper delegation of authority.
- Job knowledge.
- Merit pay increases.
- Fairness and firmness.

Among the miscellaneous workers, good communications were interpreted in terms of man-to-man contact. This group, thinking of the immediate supervisor, said a good employer should (1) make himself available always; and (2) occasionally review with each employe his work progress.

According to the foremen, the employer can realize good communications by:

- Explaining changes, whether of men, methods or material.
- Encouraging employes to suggest anything that might help the company, thus making communications a two-way street.
- Willingness to listen to his employes and to give help and encouragement where merited.

The superintendents and engineers evidenced a broader view of good communications. One superintendent said his boss should: "Keep me informed of details in my related work with other departments and operations that might affect public relations." An engineer declared: "An employer should keep his engineers informed on all matters of policy, whether affecting him directly or indirectly, except in those matters confidential to management."

The employes indicated that, in addition to drawing them closer to the boss, good communications are an aid to two other desirable attributes in their employers—proper delegation of authority and job knowledge.

Superintendents and engineers were particularly concerned with these qualifications in management, though sometimes for different reasons. The superintendents emphasized that the employer "should define your job in detail so that you can clearly understand your job and the scope of its responsibilities and authority."

The engineers were more concerned with apportioning the work load in such a manner as to avoid burdening experienced personnel with minor details.

These two groups also emphasized somewhat different reasons for wanting greater job knowledge in their employers. The superintendents were interested in the employer having a knowledge of the job that would permit him to "make prompt decisions pertaining to operation, maintenance and capital expenditures." The engineers evidenced greater interest in such matters as "careful consideration of the practicality of design of equipment. . . ."

These differences, however, were only in the matter of approach to a common goal. The survey left no doubt that the goal itself should be the creation of circumstances in which the employe can best serve his employer, thereby winning greater recognition for himself as a valued individual.

As to the manner in which that recognition should be bestowed, the group were again divided as to emphasis. Returns from the miscellaneous workers and foremen were marked only infrequently with dollars signs, whereas the occasional "pat on the back" was considered of great importance. In contrast, the superintendents and engineers were strong for merit pay increases. Since the foremen and

miscellaneous workers are usually in close proximity to their immediate supervisors, whereas the engineers and superintendents work more remotely, this difference of opinion may indicate that applause, personally and enthusiastically administered, can sometimes be as important as money to the machine-age man intent on recognition as an individual.

Except when prefaced by the word "merit" the employes did not once mention pay increases, though there was a scattering of suggestions that fringe benefits are an excellent yardstick for measuring the employer's interest in his employes.

Urge to Admire—Other attributes the employes said they would most like to see vested in their employer are commendable personal traits, of which those most often mentioned were fairness and firmness. The ability to "make a fair decision and stick to it" was cited in virtually every reply. Other such characteristics mentioned were:

- "An employer should be civic-minded, but he should perform his duties to the public and the company with as little as possible of blatant fanfare."
- "An employer should have the poise to make himself master of any situation and a show of optimism to inspire others."
- "An employer should have a sense of humor."
- "An employer should set a good example in all things which he expects of his employe."

All of which could be accepted as evidence that employes are happier, most productive, and therefore making greater progress toward personal recognition if their employer, symbol of the company in which they are investing their working lives, is deserving of their admiration, respect and pride. ##

Why Employes Quit—

(Continued from Page 104)

tance. Actually, such results are not in contradiction to the job satisfaction survey and exit interview results, because the "importance ranking" studies represent research on an entirely different variable. "Factor importance in a job" is not the same thing as

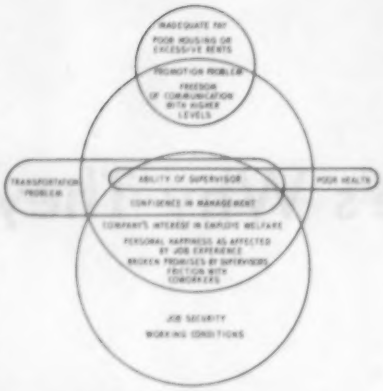


Figure 1. Motivations for quitting are woven in a complicated pattern.

what the employe is happy or unhappy about in a job. The factor importance ranking studies referred to above are cast in an abstract, theoretical frame of reference for the employe respondent. They get at his set of philosophical values. But the job satisfaction survey and exit interview get at something different: *not the importance but the satisfactory or unsatisfactory condition of each factor in current work experience.* Generalizing from all these related researches, it might be suggested that employes in general concede that pay is not the most important factor in a job, but they nevertheless feel that it represents a foremost grievance factor. This generalization is bolstered by the RCA Victor study which showed that the departments with the highest turnover had lower average pay than other units.

Eight companies cooperated in making a comparison of exit complaints with complaints made in routine personnel counselling. The relative ranking of topics in order of complaint frequency was similar to the ranking obtained on quitting personnel. This clearly suggests that the emotional content obtained from quitters may be a good barometer of grievances which are "pent up" but nevertheless existing in the non-quitting personnel.

But the most interesting findings of this research lie in the discovery of definite pattern structure of grievances.

Pattern Structure—Simultaneous mention of two or more topics of grievance was studied in order to attempt to discover which grievances tend to go together, that is, to accompany each other. Final results of this rather complicated statistical analysis are shown simply and graphically in Figure 1.

Perhaps the most conspicuous single outcome of the analysis is the presence in four of the five patterns of "ability of the supervisor." Even "poor health," which correlates with nothing else as a reason for quitting is related with (lack of) "ability of supervisor." The question of whether the supervisor is a convenient scapegoat for the employe in poor health or whether he bears a causal psychosomatic relationship to employe poor health is not clear, but probably both tendencies operate. The triad in which the supervisor also figures along with "transportation" grievances and lack of "confidence in management" suggests an interesting pattern in some companies. It appears probable that employes far away from the plant have more transportation difficulties and therefore are tardy or absent more frequently than other personnel. The supervisor (of this pattern) categorizes mentally and orients to these employes as being of the "less dependable,

See WHY THEY QUIT Page 245

Meet the Author

WILLARD A. KERR, in addition to teaching a full load of industrial psychology courses to engineering students at Illinois Institute of Technology, maintains a continuous and unsubsidized program of research in human-relations problems. Author of 67 published researches, Dr. Kerr, an associate professor, joined the faculty at Illinois Tech in 1947, after a year as assistant professor at Tulane University. A graduate of Southern Illinois University, he completed graduate studies at Purdue University in 1942. After directing RCA Victor's war-time industrial music program for two years, he entered the Navy where he served two years as an aviation psychologist.

Motor Fuel

REFINERY personnel are very concerned these days with the various aspects of the motor fuel situation. This is a round-up of three articles covering different phases. First, a survey of the opinions of refining men on the octane race, fuel volatility, and additives is presented. The second article deals with changes and trends that have occurred in motor fuels in the past ten years. The third article covers the effects of engine design changes on the required qualities of fuels. Each of these discussions covers the field from a different viewpoint and should be of aid in forming a better over-all picture of what is happening in motor fuels today.

Industry Views Motor Fuel Trends

Refinery production men think:

- **A good mixture of engine design changes and fierce competition have caused the octane race.**
- **Trend is definitely toward motor fuels with higher front-end volatility.**
- **Interest will center around octanes rather than additives this year.**

Don S. Rawlings
Petroleum REFINER Staff

DOUBLY PRESSURED by marketers and designers of automobile engines, refinery production men are taking a long look at motor fuel trends. Octane, volatility and additives are being weighed against rising costs and the time element involved in putting new units into operation. How does the industry feel about these trends? Here are the results of a survey made among these production men to get their views.

The Octane Race

With octane levels pushing past the 95 octane mark and apparently headed for 100, the refining men are concerned about the trend upward. Each successively higher octane number requires a progressively increased amount of crude oil to produce it.

These men feel that basically the trend is sound from an engineering and conservation viewpoint; IF—the octanes are use to fuel more efficient engines so that the increased losses incurred in fuel manufacture are more than offset by the increased fuel economy of the new engine design. Few of them are in sympathy, from an objective standpoint, however, with the use of the fuels simply to produce an engine which will develop 200-300 horsepower more economically than an engine of older design. The use of an engine of lower horsepower so that its efficiency can be utilized to produce the same power with less fuel appears to be more sensible.

These men are aware, however, that their plants can produce more gasoline than marketing departments can sell. At the same time, they take note that the automotive industry feels that higher compression ratio and higher horsepower are top selling points to the motorist for their new model cars.

On the matter of inventory levels, a look at the figures will show that they have shown a sharp increase since 1950. Finished gasoline stocks have risen from 108,669,000 barrels to 146,679,000 barrels between 1950 and 1954. This is due in part to the government's request during the Korean crisis that refining capacity be boosted to give a 1 million barrel per day cushion of capacity over demand. A greatly accelerated construction program resulted. In 1954, this excess capacity exceeded demand by 15 percent.[1]

Today, top octane fuels can be efficiently utilized by only about five percent of the cars on the roads. Yet sales of premium gasoline are almost on a par with regular gasoline sales. Supplying three grades of fuels is impractical. Then, too, these men feel that in all probability the same group who now buy premium fuels for cars that can not make use of them would again jump to the super octane fuel simply because nothing is too good for their car.

The number of cars which will need the higher octane fuels is increasing. In 1953, new model cars produced requiring the current high octane amounted to less than 10 percent of total cars produced. In 1955, almost 50 percent of the new models require this fuel.[2]

Competition or Engine Design Changes?—Production men are split on the question of whether competition at the retail level or requirements initiated by engine design changes is the primary driving force behind the octane race. It develops in discussion that both are about equally important.

A representative of one of the automobile manufacturers recently stated that now that high octane fuels are available, designers can make changes which will result in utilization of new fuels. To the refining men, this might have come as something of a surprise. He may have been under the impression that refiners are

trying to make a fuel that will satisfy the engines now in use in the newer models. Actually both views can be reconciled if the automobile companies are speaking of broadening the use of their high compression ratio engines in more of their different makes and if the refiner is speaking of providing a fuel for the group of extremely high compression ratio engines which are far ahead of the general run of new models.

If design changes are responsible, some of the oil companies have not been reluctant to push octane levels up to meet the new requirements nor to inform the general public of the increase. Excess stocks, of course, have a way of enticing oil companies into utilizing their octane jumps to increase sales. However, it is entirely possible with some of the high compression engines for the motorist to sort out fuels. As long as he can do this, competition for his business will force the level up.

The big campaign on gasoline additives is a factor also. Octane number is the chief talking point used to combat the effects of promotional material on additives.

No More Easy Octanes—Agreement is unanimous that the days of easy octanes are passed for premium and will soon be passed for regular grades, too. Proof that octane levels are straining existing units is the multi-million dollar expansion program now underway for units that can upgrade present products. Some of the new processing improvements will give increased product qualiy at the expense of product volume.

Octanes Above 95 Obtained by Constructive or Destructive Means?—Refining men agree that processes such as catalytic reforming, which is essentially a pure upgrading process, result in lower overall refinery yields from crude oil. On the basis of a loss in yield the octanes are obtained by more destructive means when compared to processes such as catalytic cracking where both yields and quality are improved.

Where catalytic processes are replacing thermal processes, however, yields are invariably increased. Some of the high octane components of gasoline are being produced by retiring thermal cracking facilities and replacing them with catalytic cracking units. The same is true where catalytic processes replace thermal in polymerization and reforming units.

In the over-all picture, however, yields are definitely being lowered for the refiner when he produces gasoline octane at the extremely high levels. The only justification for going into a phase where yields are lowered is for the efficiency of the automobile engine to be increased to the point where it can offset the refiner's losses. While they have no control of the situation necessarily, some of the refining men doubt that present trends are resulting in this. In any case, the increased cost of producing higher quality gasoline will have to be borne by the consumer ultimately.

How Will Future Octane Increases be Obtained?—Octane increases in the future will be gained by increased utilization of:

1. More catalytic reforming.
2. More severe catalytic cracking operations to provide additional unsaturates for alkylation unit feed.
3. More alkylation.
4. New extraction processes which will increase the aromatic content of the blending stock.
5. More polymerization.
6. More isomerization to upgrade the C_5-C_6 components.

Processes such as alkylation and polymerization offer good opportunities for using light components as converting them into heavier, high octane components

Catalytic reforming will supply the bulk of the octanes above the present levels. This is verified by looking at the construction record of these units.

At the beginning of 1954, catalytic reforming capacity stood at about 200,000 barrels per stream day. In the first six months, this total increased by 80 percent to 360,000 barrels. When all units now under contract are completed, most of which will be in operation by January 1, 1956, the total capacity will exceed one million barrels per stream day.[3]

How far can additional construction of catalytic reforming facilities prove feasible? One authority estimated that the break-point would come when reforming feed rates are 20 percent of crude rates. With crude capacity above 8 million barrels per day, a catalytic reforming facilities can be increased by another 600,000 to 700,000 barrels.

How Does the Small Refiner Fit Into This Picture?—Opinion varied among the men surveyed about the effect the octane race may have on the small refiner. Answers ranged from a simple "tough" to "his problems are very similar to those of the majors, and he should hold his own."

Opinion was as varied among small refiners interviewed as among major companies. Apparently ability to compete depends entirely on the individual company. In several instances, some of the small, progressive refiners appear to be in better position than some of the older, major refineries. This is not too surprising when considered in the light that some of the small refiners were among the very first to install catalytic reforming units. One small refiner stated that he was producing 96-97 octane at the present time. Certainly all the majors have not yet reached this level.

It is pointed out by some that the small "package" units are available in almost all the newer processes and that small refiners have made full and effective use of the smaller scale facilities to keep up. Like the majors, they have no choice but to keep up or get out. Securing capital may be the biggest obstacle to expansion, however, since most have no crude reserves and in some cases little retail marketing facilities.

What is the Top Octane Likely?—Most of the men interviewed placed the top octane level at 100, utilizing processes available at present. The feeling of one man interviewed is that since the top level is now around 97 octane, the 100 octane mark would certainly look good on company advertising copy and that some company was bound to jump the gun and shoot for it.

Not one of the men interviewed wanted to even talk about gasoline with octane above 100 since they would be the men charged with providing it in the event it came to pass.

(An interesting feature of the talk on octane level is that this issue contains an article on Page 116 describing a process which will yield a product with an octane rating of 100 clear.)

Volatility

What about Front-End Volatility?—The official position of most of the companies surveyed is that front-end volatility is maintained as high as

possible consistent with satisfactory performance in the automobile.

How high the vapor pressure can go is limited by both the operating troubles and in some states by laws regulating the maximum. Operating troubles encountered when the vapor pressure is too high include carburetor icing and vapor lock, both of which can be solved by changes in the engine design and in their fuel intake systems. One of the solutions mentioned most often is the conversion to a pressure fuel system with the fuel pump installed in the gasoline tank at the rear of the car. Estimate of the cost of doing this for the automobile manufacturer is $20-$25 per car, a figure small enough in itself but of major size when applied to the manufacture of, say, a million vehicles.

Increased Volatility Holds Opportunity for Real Savings — Everyone agreed that higher vapor pressure and front-end volatility in gasolines would put money in the refiner's pocket. Most of the money would accrue from the more economical utilization of such components as normal butane. Put into gasoline, this component has a much higher value than when burned as fuel. Besides, in this particular case, the butane has an extremely high octane blending number — 104. Additional savings could be made to some degree because this blending component would raise the over-all octane number of the blend or would help support some components weaker in this characteristic.

Have Companies Revised Their Specifications in Recent Years on Volatility?—Without exception, the companies surveyed reported that their specifications on volatility have been revised upward in recent years on both grades of gasoline. The extent of the revision has varied considerably. Some companies have apparently had some bad experience where the vapor pressure specification was allowed to go too high and have backed off to avoid customer complaints, but levels remain higher.

Tail-End Volatility

Oil companies differ in their outlook on the amount of high-boiling components the gasoline should contain and also on where the end-point should fall. Opinions vary on at least two scores:

1. The performance advantages and disadvantages of the higher boiling components.
2. Whether the refiner has available high octane, high boiling components.

Some companies regard the lowering of the end-point and 90 percent point as being a definite improvement in gasoline quality and place considerable importance on maintaining it lower than the competition.

They state that high boiling components have the disadvantage of poor burning characteristics which leave deposits in the cylinders, allow dilution of the crankcase oil, cause spark plug sooting, and result to a lesser extent in poorer warm-up and acceleration. One company representative stated that while octane number of some of the higher boiling components could be improved they still retained poor burning characteristics. And, therefore, in his opinion they should be removed.

On the other side, production men point out that some of these components, especially the aromatics, are very high octane and must be included in the gasoline for cost reasons.

Does Lower End-Point Specification Conform with Increased Use of Catalytic Reforming?—One of the characteristics of most catalytic reforming operations is that it produces a great deal of high boiling components in upgrading the feed stock. The aromatics produced have extremely high octane number and play a very important role in the octane race. A company committed to a policy of maintaining a relatively low end-point may find itself in the squeeze when the proportion of catalytic reforming stock in the blend is increased. One solution suggested is that some of the high boiling components can be utilized by allowing the production of jet fuel to cut into the back end of the gasoline fraction. However, aromatics constitutents are not favored for jet fuel.

The general feeling is that the end-point of gasoline will for economic reasons be kept at present levels or raised as the amount of catalytic reforming stock is increased. In any case, they feel that the pressure will very definitely be toward forcing it higher. Others feel that by careful selection of feedstock to the reforming unit and control of operation conditions this problem can be controlled and end-point can still be lowered. The jet fuel cut might be increased on stocks which do not have the high aromatic content of the catalytic reforming stock.

Motor Fuel Additives

All is apparently quiet on the additive front. The main interest has been shifted to octanes. The general feeling is that the additive field is fairly static at the present time although no one ruled out the possibility of some new developments. Satisfaction is expressed that competition among the major companies supplying these products to the oil industry are keeping developments coming at a satisfactory rate. Many express hope that some new additives in the field of pre-ignition will be forthcoming.

The additive field is big business for the suppliers and they have a big stake in seeing that research is directed along proper channels. Total additive consumption last year was about 750 million pounds.

Conclusions

How to get octanes is the big question in the minds of the gasoline production men. They feel that there is little likelihood that premium gasoline will stop short of 100. Catalytic reforming will be the principal means for increasing octane number although definite interest was expressed in operations enabling the use and upgrading of the light hydrocarbons in the C_3-C_6 range. They hope that better catalysts will become available for many of their operations.

No one was worried particularly about the introduction of the gas turbine into general use in automobiles. Best estimates place the first turbine at least five years away and even then there will still be many cars on the road needing high octane gasoline.

Competition is expected to get even worse and the outlook has these men digging in order to assure that their company does not get left at the gate.

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Motor Fuel

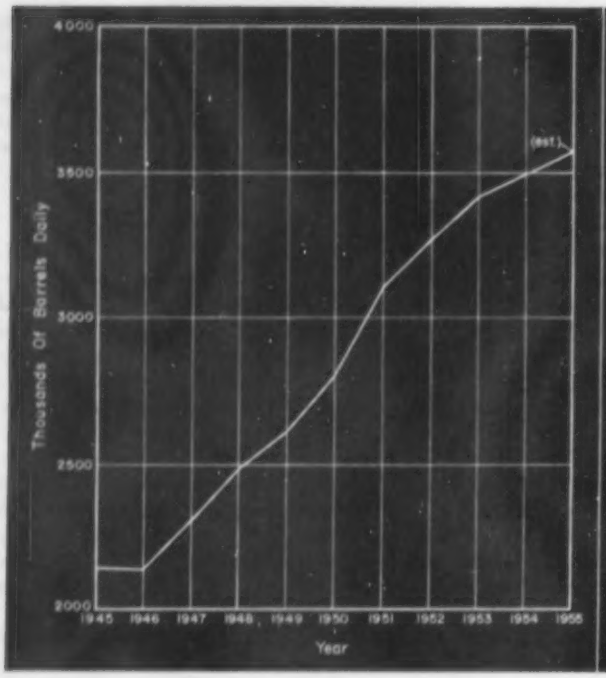

Figure 1. Total motor fuel demand for the period 1945-54. (Source: U. S. Bureau of Mines.)

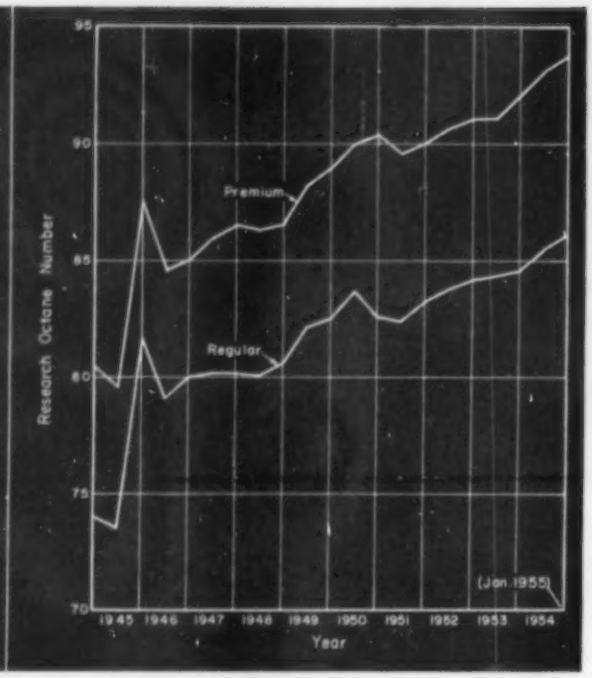

Figure 2. Trend in national average research octane for premium and regular gasoline. (Source: U. S. Bureau of Mines.)

Motor Fuel

Ten Years of Change for Motor Fuel

Quality improvement coupled with production increases have resulted in a fast-paced postwar period for motor fuels.

INDUSTRY HAS answered the postwar challenge of rising costs and sharper competition with the most important advancements in the history of motor fuel.

What has happened in the field of motor fuel production since 1945?

- Production has outstripped demand.
- Octane numbers have soared.
- Prices have increased under cost pressures.

Gasoline Demand

Demand and production of gasoline have been on the increase since 1945. The postwar period has seen extensive construction of new catalytic cracking, alkylation, polymerization, and reforming facilities. Virtually all units demanded by gasoline quality have been expanded. Naturally this production boost has been accompanied by the increases in demand shown in Figure 1. Average daily demand has risen from 2.149 million barrels in 1945 to 3.484 million in 1954, an increase of 62.1 percent. Estimated demand for 1955 is for a daily average of 3.562 million barrels. These data are tabulated in Table 1. Production facilities at this time are more than sufficient to supply all demand, and current interest centers around quality improvement.

Octane Number

While octane number has risen steadily since mid-1946, the real upsurge did not begin until 1949. This was the same year in which the many major design changes in automotive engines were being initiated.

TABLE 1

Demand for Gasoline, by Years
Total, domestic, and export demand supplied by U. S. petroleum industry.
(Source: U. S. Bureau of Mines)
THOUSANDS OF BARRELS

	Total Demand		Domestic		Exports	
Year	Annual	Daily	Total	Daily	Total	Daily
1945	784,392	2,149	696,333	1,908	88,059	241
1946	780,751	2,139	735,417	2,015	45,334	124
1947	842,464	2,308	795,015	2,178	47,449	130
1948	908,572	2,482	871,270	2,380	37,302	102
1949	953,060	2,611	913,713	2,503	39,347	108
1950	1,019,011	2,792	994,290	2,724	24,721	68
1951	1,132,087	3,102	1,091,951	2,992	40,136	110
1952	1,193,565	3,261	1,157,280	3,162	36,285	99
1953	1,243,700	3,407	1,205,775	3,303	37,925	104
1954	1,272,809	3,487	1,238,346	3,393	34,463	94
1955 Est.	1,300,000	3,562	1,272,000	3,485	28,000	77

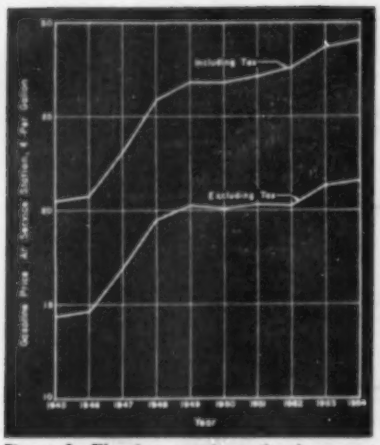

Figure 3. The increase in national average service station gasoline prices. (Source: The Texas Company, via API.)

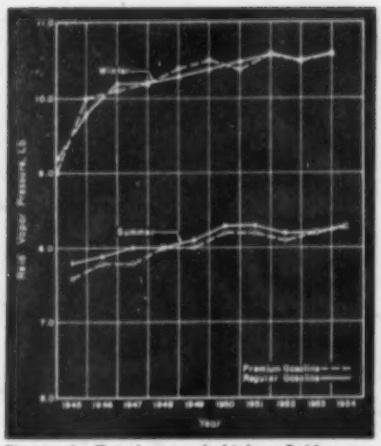

Figure 4. Trend toward higher Reid vapor pressure for average gasoline. (Source: U. S. Bureau of Mines.)

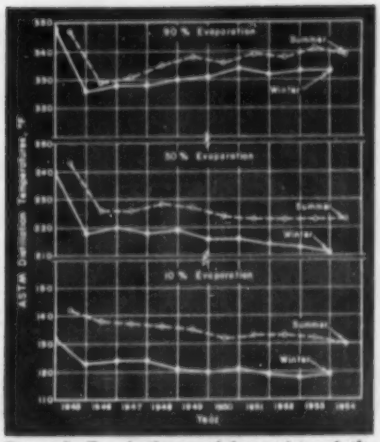

Figure 5. Trend of several key points of the average gasoline ASTM distillation curve. (Source: U. S. Bureau of Mines.)

Available figures for the national average Research octane number have been plotted in Figure 2 for both premium and regular grades.[1] While these figures indicate the over-all trend, undoubtedly leaders in the refining field have been marketing gasoline which has shown even greater increases in octane number. It is obvious that large jumps in octane number would be leveled out by such average figures.

Even so, since the low point in mid-1945, the octane number for premium grade gasoline has increased from 79.6 to 93.6, the latest available figure for samples taken around January 1, 1955.[2] This is an amazing 14.0 octane number increase. While not so great as for premium gasoline, regular grades have also increased during the same period from 73.3 to 86.2 octane, rising 12.1 numbers. The 86.2 figure puts regular grade at the same level as premium in 1948.

Since the first of the year, some of the oil companies have been marketing premium grade gasoline with an octane number up around 97. The highest octane reported in the January report was 95.5. All indications are that the 97 figure will be exceeded before the year is out.

TABLE 2
U. S. Average Prices of Gasoline in 50 Cities, by Years
(Source: The Texas Company, via API.)

YEAR	Gasoline (¢ per Gallon)			
		Service Station		
	Dealer's Net	Excl. Tax	Tax	Incl. Tax
1945	10.33	14.48	6.02	20.50
1946	10.40	14.89	6.08	20.77
1947	12.33	16.98	6.18	23.11
1948	14.55	19.54	6.34	25.88
1949	15.05	20.27	6.52	26.79
1950	15.10	20.08	6.68	26.76
1951	15.33	20.31	6.84	27.15
1952	15.27	20.24	7.32	27.56
1953	15.96	21.28	7.41	28.69
1954 Est.	16.19	21.89	7.48	29.07

Gasoline Prices

An inflating economy plus product quality improvement would logically result in price increases. Such has been the case. The extent is indicated in Figure 3 and Table 2 for regular grade gasoline. These are not individual gasoline prices in a specific area but are again national averages.

The steady trend upward of service station prices is evident. The greatest increase occurred between 1946 and 1949 when the price, excluding tax rose a total of 5.79 cents per gallon. The price has gone up only 1.32 cents per gallon since 1949. This is certainly an indication that price increases do not keep pace with quality improvement since the last six years have been the period of greatest octane number increase.

Tax increases since 1945 have raised the cost of gasoline to the consumer from 20.50 cents per gallon to 29.07, an increase of 9.02 cents. This means that almost two cents per gallon of the increase was not under the control of the refiner. While the figure of 29.07 approaches the all-time high since 1918 of 29.83 (for 1920), the gasoline is naturally many times higher in quality.

Vapor Pressure

There has been a general trend toward higher vapor pressures in both premium and regular grades of gasoline. Among the most important factors limiting vapor pressures from going even higher have been the problems of carburetor icing and vapor locking. Refiners have, however, been edging closer to the maximum allowable vapor pressures.

This trend is shown in Figure 4. Reid vapor pressure of winter grades has been increased by about 1.5 pounds on the national average for premium gasolines[1]. Summer grades have lagged behind this increase, however, and have increased only about 0.5 pounds. Refiners are apparently making every effort toward this means of utilizing some of the low-boiling, high-octane blending rating components such as normal butane.

ASTM Distillation Curve

To indicate what the trend has been in regard to the shape of the ASTM distillation curve for gasoline, the 10, 50 and 90 percent points are plotted in Figure 5 for premium gasoline. These figures are again based on the national average[1]. The distillation temperatures have been lowered for both the 10 and the 50 percent points for both summer and winter gasolines. This would, of course, indicate the use of more light components. The 90 percent point, on the other hand, has been coming over at a slightly higher temperature.

The end-point of the average gasoline during the period since 1945 has not shown any trend or much change.

General

The most dramatic change in gasolines, then, has been in connection with octane number as would be expected. None of the other characteristics discussed have changed to the same degree. But, some of these show definite trends which may indicate the future course for gasolines.

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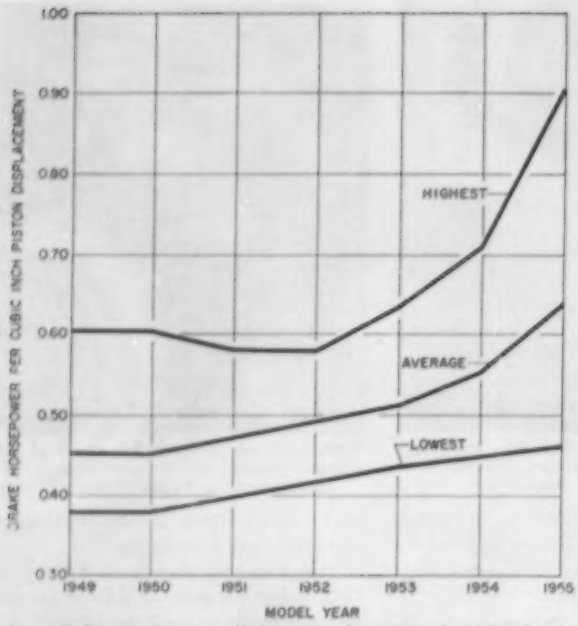


Figure 1. Increased engine efficiency is indicated by the higher horsepower developed from each cubic inch of piston displacement.

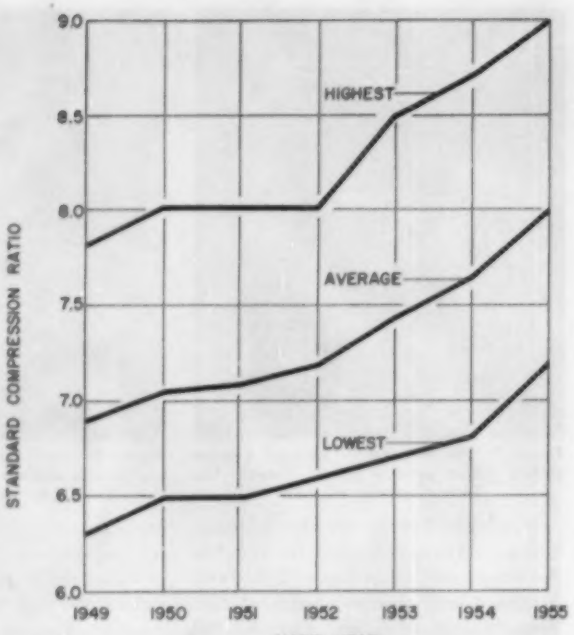


Figure 2. Trend in compression ratios, based on models offered.

Motor Fuel

Trends in Automotive Engine Design

Here is the way they affect gasoline quality requirements

Burr J. French
Ethyl Corporation
Detroit, Michigan

THE SIX YEARS which have elapsed since the first high-compression V-8 engine of modern overhead-valve design came off the production line unquestionably represent one of the most intensive periods of engine research and development in automotive history. The resulting developments, coupled with other automotive changes which affect engine operating conditions, have enabled the automotive industry to take full advantage of the higher-quality gasolines produced by the petroleum industry.

In an industry where the life of a basic engine is normally measured in decades, 19 new engines have been introduced since the fall of 1948. All incorporate overhead valves, while 18 are of V-8 design. The ascendance of the overhead-valve V-8 can be statistically demonstrated by comparing 1949 and 1954 engine production. In 1949, V-8 engines (mostly of L-head design) were installed in only 23.7 percent of car production. By comparison, overhead-valve V-8 engines powered 56.3 percent of the cars produced in 1954. Moreover, since several additional overhead-valve V-8's were introduced in 1955 models, it is estimated that engines of this design will claim over 80 percent of the 1955 production. They have completely supplanted the straight eight and L-head V-8 engines, as well as a large share of the six-cylinder powerplants.

Although the new engine designs differ according to the design philosophy of their manufacturers, all share three basic advantages:

1. The overhead-valve design opens the way to higher volumetric efficiency, by permitting larger valves and freer flow of gases to and from the combustion chamber.

2. The V-8 layout provides the structural rigidity required for efficient, smooth and durable engine operation when compression ratios are raised for improved thermal efficiency.

3. The oversquare bore-and-stroke of the new V-8's, in which the bore exceeds the stroke, provides better mechanical efficiency by lowering piston speed and thus friction losses. Mechanical efficiency has been further improved by the universal adoption of three-ring pistons, which reduce friction losses without impairing control of lubrication and blowby.

Ample testimony to the achievement of improved engine efficiency can be found in engine-performance trends since 1949. During this period, average brake horsepower ratings (based on models offered) rose from 111.8 to 178.6 in 1955, while the maximum horsepower available for an individual car increased from 160 to 300. Although these horsepower increases have been achieved, in part, by enlarging piston displacement, the major gains have resulted from design changes for greater efficiency. As a result, brake horsepower per cubic inch of piston displacement, one criterion of engine efficiency, has climbed from an average of 0.448 in 1949 to 0.638 in 1955, as shown in Figure 1. Significantly, all but two of today's overhead-valve V-8 engines exceed the maximum value of 0.603 in 1949, the top figure in 1955 being an amazing 0.906.

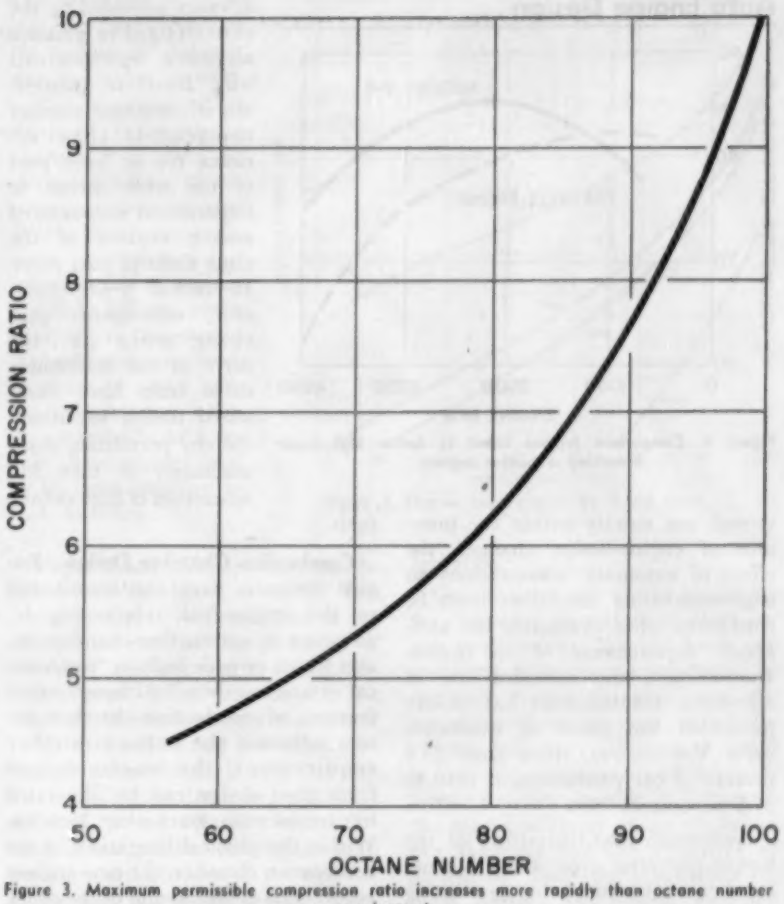


Figure 3. Maximum permissible compression ratio increases more rapidly than octane number requirement.

Octane-Number Requirement

The improved performance of modern engines stems from a combination of higher mechanical efficiency, achieved through a reduction in friction losses; higher volumetric efficiency, accomplished by means of larger valves, modifications in valve timing, four-barrel carburetors, and improved manifolding; and improved thermal efficiency, primarily realized through increases in compression ratio and combustion chambers having lower surface-to-volume ratios. Of these factors, improved volumetric efficiency and higher compression ratios both have a direct effect on the octane-number requirement of an engine because they raise the gas pressures within the combustion chamber.

Figure 2 shows how compression ratio has steadily increased in recent years, rising from an average of 6.88 in 1949 to 8.00 in 1955. As would be expected, the trend to higher compression ratios has been accompanied by a rise in antiknock requirement. However, one factor sometimes overlooked in the engine-fuel relationship is the nonlinearity of the octane scale in respect to compression ratio and engine performance. The nature of the octane scale is such that each successively higher unit has greater knock-suppressing effectiveness. This is graphically shown in Figure 3, which reveals that the maximum permissible compression ratio of an engine of good design increases much more rapidly than does its octane-number requirement.

Volumetric Efficiency—The rash of publicity given to "high-compression" engines in recent years makes it easy to forget that factors other than compression ratio influence their octane-number requirement. As mentioned, one of these factors is volumetric efficiency—the breathing capacity of an engine.

Design changes in modern engines have usually been aimed at improved volumetric efficiency in the high speed range, where breathing becomes restricted due to the reduced time available for filling the cylinders. These changes include larger intake valves, higher valve lift, and longer valve-open periods with greater overlap between the time the intake valve opens and the exhaust valve closes. Figure 4, which compares the volumetric efficiency of a modern V-8 engine with its in-line eight predecessor, is representative of recent trends.

In addition to contributing substantially to the higher rated outputs, the improved volumetric efficiency at high speed has raised the average engine speed at rated output from 3660 rpm in 1949 to 4279 rpm in 1955. The general effect, therefore, has been a tendency to raise the octane requirement of engines during high-speed operation. In the normally-critical low speed range, however, these changes have had little or no boosting effect on volumetric efficiency, and thus on octane requirement. As a result, the trend has been to decrease the difference between the octane-number requirement at low and high engine speeds.

Automatic Transmissions—Al-

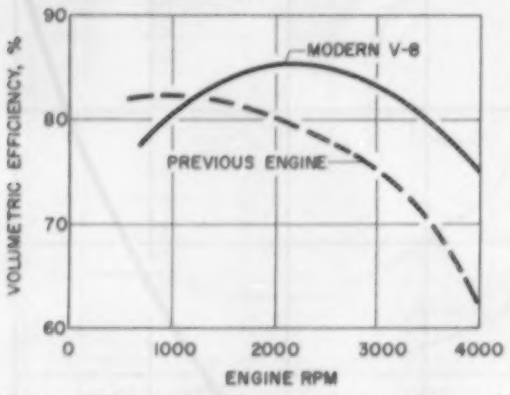


Figure 4. Comparison typifies trend to better high-speed breathing in modern engines.

though not strictly within the province of engine-design changes, the effect of automatic transmissions on engine-operating conditions must be considered when evaluating the anti-knock requirements of an engine. Interestingly, the extended use of automatic transmissions has closely paralleled the climb of overhead-valve V-8 engines, rising from 25.4 percent of car production in 1949 to 57.5 percent in 1954.

Automatic transmissions of the torque-converter type affect octane-number requirement by preventing full-throttle operation at speeds below about 1600 rpm, where knocking would otherwise be most pronounced. With three-speed, manually-operated transmissions, the maximum octane-number requirement usually occurs in the engine speed range of 800 to 1200 rpm. *The use of automatic transmissions shifts the critical speed for knock to the higher range of 1600 to 2500 rpm. If no engine changes were made, this would reduce maximum octane-number requirement by as much as 2 to 4 units. However, manufacturers usually utilize these "extra" octane numbers to raise compression ratio or advance ignition timing.*

Ignition Timing—The important role that ignition timing plays in octane-number requirements is generally understood. *This effect varies from about 0.5 to 2.0 octane units for each crankshaft-degree change in spark advance, depending on engine design and, to some extent, on octane-number level.* Variations in either basic timing or the automatic spark advance provided by the centrifugal or vacuum advance mechanisms will, therefore, materially affect octane-number requirement; they account for at least part of the wide spread in requirement encountered among engines of the same make in past years. In recent years, however, refinements providing more positive drive in the distributor drive train have minimized timing variations, thereby permitting manufacturers to take full advantage of high-octane fuels.

Combustion Chamber Design—Engine designers have also contributed to the engine-fuel relationship by advances in combustion-chamber design which provide built-in "mechanical octane numbers." Although many features of combustion-chamber design influence the octane-number requirement, the benefits derived from good design can be illustrated by considering spark-plug location. Within the physical limitations of the combustion chamber, the new engines reveal careful positioning of the spark plug, with respect to the cross-section of the combustion chamber and location of the valves, in order to provide the shortest path of flame travel. The gains to be realized from such design care were dramatically demonstrated when relocation of the spark plug from a central location in the combustion chamber of a production engine to a point in the side of the combustion chamber raised the octane-number requirement from 79 to 94. Additional mechanical octane numbers have been realized by machining the combustion chambers or exercising closer foundry control for more uniform combustion-chamber volume, improving manifolding for better distribution of the air-fuel mixture and carefully designing cooling systems to eliminate or minimize hot spots within the combustion chamber.

Combustion Chamber Deposits—One problem of considerable concern to both refiners and engine designers is the combustion-chamber deposits formed by the fuel, the lubricating oil, and their additives. These deposits tend to raise the octane number required to suppress knock by heating the intake charge and by increasing the compression ratio due to their physical volume. In addition, they serve as a source of surface ignition, which results in uncontrolled and erratic combustion.

Although opinions differ as to the severity of the surface-ignition problem, present engine-design trends appear to indicate that surface ignition, if allowed to go uncontrolled, may become a limiting factor in future engine development. Higher compression ratios raise maximum cycle temperatures, and so lead to increased tendencies toward surface ignition. Also, the trend to higher volumetric efficiencies at medium and high engine speeds results in more heat release per engine cycle and an increased tendency to surface ignition in these speed ranges.

Meet the Author

BURR J. FRENCH, with a broad background in both the petroleum and automotive industries, is an engineer whose interest in writing dates back to when he was editor of his engineering college magazine. Formerly technical editor for Chrysler Corporation and later engineering editor for Motor magazine, French is now technical analyst and writer for Ethyl Corporation's Information Services division, where he is responsible for preparing technical articles for Ethyl's research laboratories. French, a mechanical engineer, joined the Chrysler Institute of Engineering shortly after he was graduated from the University of Michigan in 1942 and held various engineering positions with the company before he was named to its editorial post. From there he began his stint as a professional in technical writing.

Despite intensive studies by engine designers on the effect of combustion-chamber configuration on surface ignition, the prospects of overcoming this problem by engine design alone do not appear promising. It seems, therefore, that a solution must stem from improvements in fuels and lubricants, including the use of additives.

The combined effect of these and other factors on octane-number requirements is shown in Figure 5, the criterion being trace knock on a level road. The requirements are based on engines in which the deposits, and thus the octane-number requirement, have reach a stabilized condition.

Fuel Volatility

A factor of major concern to engine designers is the volatility of the fuel or, more specifically, its distillation curve. Unfortunately, the engine has conflicting requirements with respect to fuel volatility. This is especially true during winter operation when a fuel of high volatility is required for satisfactory starting and warm-up characteristics, while a fuel of low volatility is desirable to combat carburetor icing. During summer operation, a major factor controlling usable fuel volatility is the danger of vapor lock. Traditionally, refiners have tailored fuel volatility for the seasons, reducing volatility during summer operation to minimize vapor lock and raising volatility during the winter months to improve cold starting and warm-up.

Carburetor Icing—Carburetor icing occurs when the atmospheric conditions and fuel volatility are such that evaporation of the fuel within the carburetor causes the temperature of the throttle valve and body to drop below 32F., with the resulting formation of ice. Sufficient buildup of ice will restrict air flow when the throttle valve is closed for engine idling, thereby causing the engine to stall.

From the standpoint of engine design, the primary factors affecting carburetor icing are the idling speed and the throttle-blade temperature. Recent trends affecting throttle-blade temperature include the adoption of aluminum throttle bodies, which transfer heat more rapidly from the intake manifold to the throttle blade, and provisions for heating the throttle bodies by means of exhaust gas or engine coolant.

The beneficial effect derived from these changes is opposed by the extended use of automatic transmissions. With these transmissions, recommended idling speeds of engines are 50 to 150 rpm lower than when three-speed transmissions are used, in order to avoid having the car creep when at a standstill. As a result, these engines tend to be more sensitive to fuel volatility.

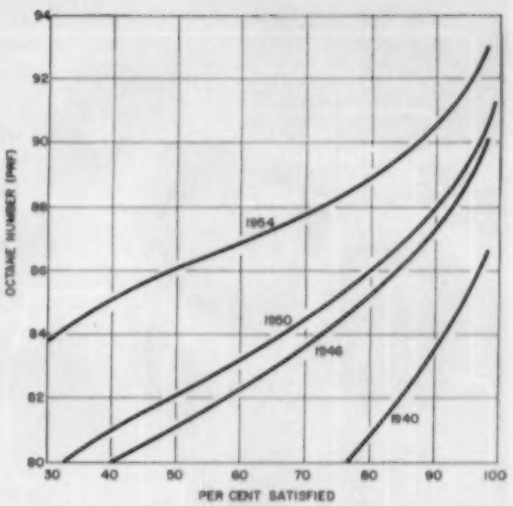


Figure 5. Octane requirements by model years.

Vapor Lock—Vapor lock can be defined as the inability of the fuel pump to supply sufficient fuel to the carburetor due to the presence of excessive gasoline vapor within the fuel system. When this occurs, the level of the fuel in the carburetor drops to a sufficiently low value that engine performance is affected adversely. Vapor lock is primarily affected by the volatility characteristics of the gasoline and by the temperature and pressure of the gasoline in the fuel system. Reid vapor pressure is often used as a relative indication of the vapor-locking tendencies of gasolines, a fuel with low Reid vapor pressure normally (but not always) forming less vapor under the same operating conditions than a fuel of higher Reid vapor pressure.

Recognition of the contributions obtainable by good fuel-system design in combating the vapor-lock problem is apparent in recent vehicles. In general, careful attention has been given to the routing of fuel lines in order to avoid high-temperature areas within the engine compartment, such as the exhaust manifold. In addition, most modern V-8 engines carry the fuel pump mounted low on the front of the engine. This position offers two definite advantages. First, the low mounting reduces the suction head on the fuel pump, and thus increases the ability of the pump to handle vapor. Second, the pump's location allows it to take full advantage of the blast of cooling air from the radiator fan, thereby tending to reduce temperature rise during engine operation.

On the debit side of the ledger are the "outside" factors that affect engine environment. The low hoods and restricted grille openings dictated by car-body styling demands, and the underhood insulation added for quieter operation all tend to result in high engine-compartment temperatures. Another outside influence is the recent addition of air-conditioning systems for the comfort of passengers. Since the condensers for these systems are usually mounted ahead of the radiator, the heat removed from the passenger compartment is thus dumped into the engine compartment. Recent tests on a modern car revealed that stabilized fuel-pump temperatures during 60 mph operation were 16 F. higher when the car was equipped with air conditioning, thereby reducing the Reid vapor pressure tolerance from 8.1 pounds to 5.5 pounds.

Modern engines and today's gasolines attest to the dynamic progress made in engine-fuel relationships. This progress, which stems from healthy competition and close cooperation among automotive manufacturers and petroleum refiners, has produced real benefits to the automotive public in terms of both improved engine performance and better fuel economy. ##

End of Symposium.

Motor Fuel

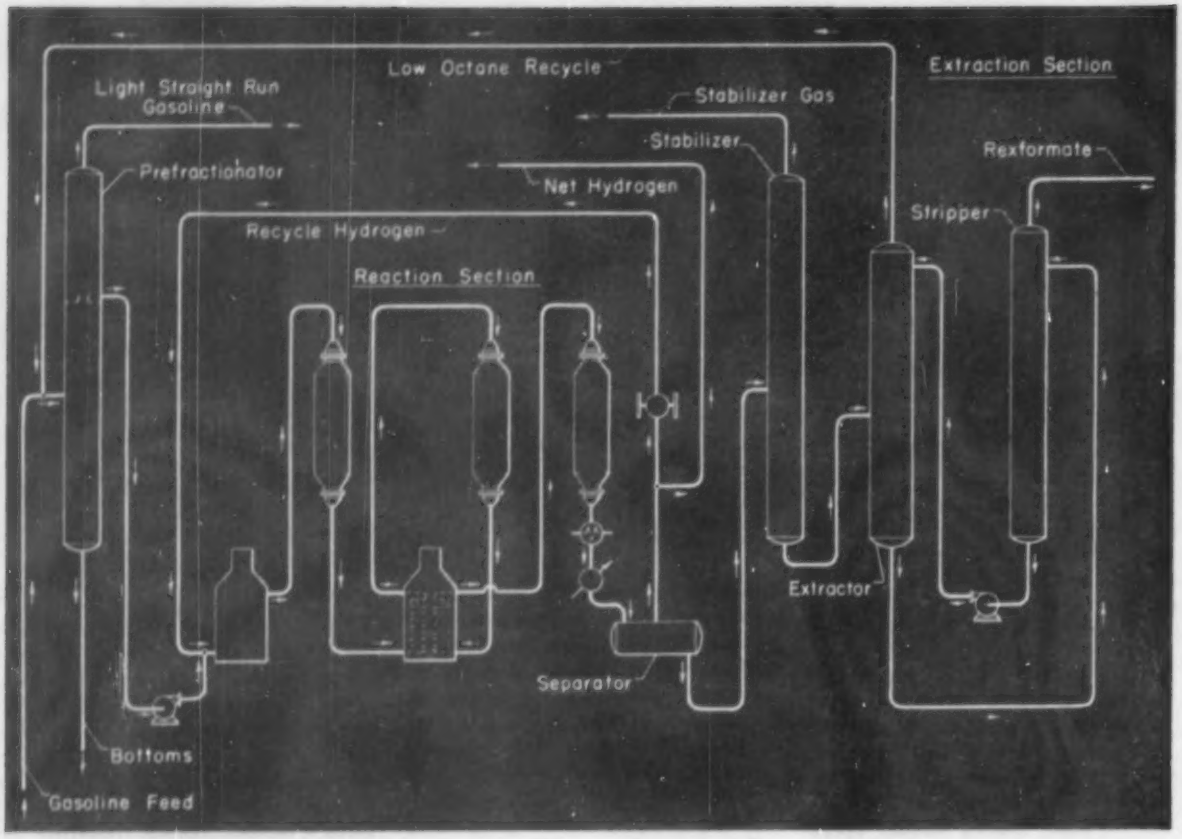


Figure 1. Rexforming flow diagram. Existing Platformer equipment can be utilized.

Rexforming . . . for Octanes Over 100

New catalytic reforming process produces super-quality gasoline by the use of a solvent extraction technique coupled with recycle of low-octane material.

H. W. Grote, V. Haensel and M. J. Sterba,
Universal Oil Products Company,
Des Plaines, Illinois

REXFORMING is a new process for the production of fuels which will satisfy the octane requirements of the most demanding cars now under development by the automobile industry (over 100 clear octane).

The ability of the process to produce super quality fuels as a major proportion of the total refinery gasoline output is associated with the use of a solvent extraction technique coupled with recycle of low octane material. Such low octane components do not appear in the finished Rexformate, which is a water white gasoline of controlled volatility characteristics. Due to the mild process conditions employed, side reactions are minimized, catalyst life is extended, and over-all yields are excellent at super-octane levels.

The recycle nature of the Rexforming process provides an additional process variable which frees refiners from operating limitations imposed by characteristics of their feed stocks. For instance, low naphthene feeds can be processed as conveniently as stocks of more normal naphthene concentration, as Rexforming permits

–Meet the Authors–

HENRY W. GROTE is assistant manager of Universal Oil Products Company's Research and Development Laboratories at Riverside, Ill. He joined Universal as a chemical engineer shortly after he was graduated from the University of Michigan. In that capacity, he was concerned with catalytic production and testing, process design of commercial units and the construction and operation of commercial process plants. Before rising to his present position, Grote served as manager of the Company's Pilot Plant division.

Grote

VLADIMIR HAENSEL, coordinator of Universal's Cracking Research division, joined UOP as an assistant to V. N. Ipatieff, after he received his master's degree from Massachusetts Institute of Technology, and helped set up the Ipatieff High-Presssure Laboratory at Northwestern University. He received his doctor's degree at Northwestern in 1941 and returned to Universal as a research chemist. In 1945, Dr. Haensel inspected the German synthetic-oil plants as a member of the Technical Oil Mission for the Petroleum Administration for War.

Haensel

MELVIN J. STERBA, who is concerned with various phases of the development of catalytic cracking units for Universal, received his chemical engineering degree from the University of Wisconsin in 1932. He became associated with C. F. Burgess Laboratories in Madison, Wis., where he worked on the production of titanium dioxide from titanium-bearing ores. He joined Universal in 1935, as a member of its Engineering Research department, and engaged in the correlation of laboratory, pilot-plant and commercial data on thermal cracking, reforming, hydroforming and catalytic cracking units.

Sterba

much more desirable paraffin conversions than are possible in single pass operations.

A Rexforming installation utilizes in an integrated manner well established refinery unit operations. It operates at high space velocities, and catalyst requirements are about the same as those needed for single pass operations to much lower severities. Units can be readily installed utilizing equipment from existing Platformers. For the same fresh feed rate no additional catalyst is required, some additional heat exchange equipment must be added, and the solvent extraction section is required.

It is estimated that a Rexforming installation of the type described will cost about $300 per barrel to build and about 36 cents per barrel to operate excluding royalty, depreciation, administration and overhead costs. Such a Rexforming unit will permit gasoline productions of any needed octane rating, and has in addition the flexibility for producing paraffinic specialty products.

Description of Process—The flow diagram, Figure 1, shows that the Rexforming process consists of several integrated parts—feed refractionator, the reaction section, a stabilizer and an extraction section.

Consider the processing of a full boiling range gasoline. This charging stock is fed to a reboiled prefractionator which removes overhead a light gasoline fraction. The side-cut from this column is the combined feed to the reaction section. The flow through the reactors which contain the Platforming catalyst, and through the heaters is similar to that of a Platforming unit. The reactor effluent, after cooling, passes to a separator, from which a hydrogen rich gas is circulated to the reactors. The net vent hydrogen is also removed from this separator.

The separator liquid is fed to a stabilizer which in this case serves as a debutanizer. The stabilized material is charged to an extraction column, which continuously rejects from the top of the column the low octane number components. This rejected stream is returned to mix with fresh feed, achieving selective conversion of low octane heavy paraffins to high octane components. The separation in the extractor is selective in that the higher boiling non-aromatics, and these are the lowest octane constituents of a reformate, are least soluble in the solvent. On the other hand, the aromatics and the lower boiling non-aromatics, both of which are the

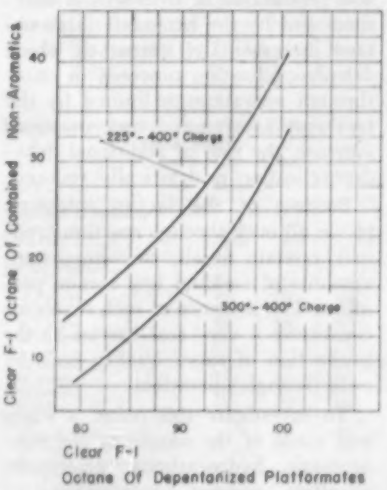


Figure 2. Octane ratings of non-aromatics from Platformates: A fraction that needs upgrading.

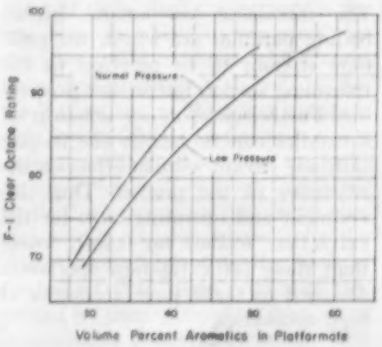


Figure 3. Platformates from Fischer-Tropsch Naphtha: How operating pressure affects aromatic content.

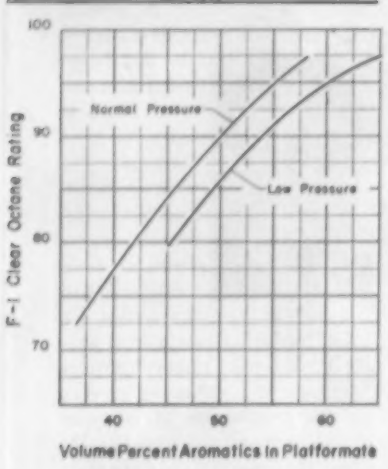


Figure 4. Platformates from Kuwait naphtha: How operating pressure affects aromatic content.

high octane components, are relatively more soluble and are removed from the extractor with the rich solvent.

Dissolved hydrocarbons are removed from the rich solvent by stripping, yielding a gasoline of well balanced boiling range as the high octane product of the process. Lean solvent from the stripper is returned to the extractor to complete the solvent cycle.

In the Rexforming process, the reaction section can be operated at mild conditions to produce an effluent having an octane number of 75 to 85 F-1 clear and containing 35-45 percent aromatics. The extraction section serves to separate from this effluent a stream of increased aromatic content, containing the highest octane paraffins in the reactor effluent. This stream, the Rexformate, when of 100 clear octane number, will contain 60-65 percent aromatics. The remaining low octane, higher boiling paraffins are left in the raffinate stream, to be recycled to the reforming section for further processing. Furthermore, minor amounts of aromatics can be left in the recycle raffinate stream without effect on the efficiency of the process. Thus, investment and operating costs for the extraction section are much lower than those for extraction operations designed to make pure aromatics at high recoveries.

Production of Super-Fuels—Earlier discussions of reforming have stressed that for an ideal operation all components of the charging stock should be converted into higher octane number materials. Emphasized was that the ideal process should be effective for a wide variety of charging stocks.

The usual charge stocks to reforming operations contain small amounts of aromatics, the balance being naphthenes and paraffins. The aromatics are of excellent octane quality, and are stable at reforming conditions.

The primary reaction of naphthenes in catalytic reforming is the essentially complete conversion to aromatics by dehydrogenation.

Paraffins undergo three reactions: isomerization, hydrocracking, and dehydrocyclization. The isomerization reaction is the fastest of the three but it is useful only at moderate octane levels because the equilibrium mixture contains substantial proportions of low octane paraffins. Hydrocracking is a potent means for upgrading the higher molecular weight paraffins, which are of extremely poor octane. The octane number increase obtained is substantial, and yields are excellent due in large part to the fact that the products are of lower density than the parent hydrocarbons. However, the extent of this reaction must be properly balanced with the other reforming reactions because of volatility specifications. Dehydrocyclization, or the conversion of paraffins to aromatics and hydrogen, is an important and effective means of improving octane ratings. The fact that this reaction involves a substantial volumetric loss due to both density change and production of hydrogen is overshadowed by the extremely large octane increase. The extent to which dehydrocyclization proceeds in once-through operations is limited by the fact that as aromatic concentrations increase, the rate of additional dehydrocyclization is drastically reduced.

Because of the factors discussed above all once-through reaction products contain small, but important, amounts of residual low octane paraffins. The presence of such materials constitutes a very real barrier to the production of super quality fuels by once-through operations.

To investigate this point, a study was made of the nature of the non-aromatic hydrocarbons, principally paraffins, present in a variety of Platformates. The octane ratings of such materials vary with feed stock naphthenicity and boiling range, as well as reforming operating conditions and conversion level, so that no simple relationships exist. Figure 2 shows typical data obtained from Platforming of Midcontinent naphtha fractions. For Platformates of 95 to 100 clear F-1 octane rating, the contained non-aromatics range from 20 up to 40 clear octane, with the lower values being associated with the higher boiling feed naphtha. At higher severities, the non-aromatic portion increases in octane number due to selective removal of heavier paraffins both by dehydrocyclization to aromatics and by hydrocracking to lower boiling, less reactive, and higher quality paraffins. A detailed examination of the non-aromatic portion of a different Platformate is given in Table 1. It will be noted that the lowest octane ratings are associated with the highest boiling fractions.

It is evident from these data that even a few percent of the higher boiling non-aromatics are seriously detrimental in super-octane fuels. Something had to be done to such low quality non-aromatic hydrocarbons before they could be economically used. A new procedure was required which would eliminate the barrier placed by the low octane paraffins.

One procedure considered for offsetting the presence of low octane paraffins was operation at reduced pressures. Such an operation increases the production of aromatics, but leaves poorer quality paraffins in the product. Examination of the curves of Figures 3, 4 and 5 shows that for three very different feed stocks, lower pressure operations require higher concentrations of aromatics at given octane levels over the entire octane range. This can only mean that the non-aromatics in these products are of poorer quality at the lower pressures.

Aromatic concentrations in motor

TABLE 1
Non-Aromatics From a Platformate

Fraction No.	Fraction Boiling Range °F.	Fraction Volume % of Total	F-1 Clear Octane No.
1	Up to 115	14.4	....
2	115-142	9.9	80.5
3	142-151	10.0	68.7
4	151-157	10.0	47.4
5	157-194	9.9	63.2
6	194-199	10.2	55.6
7	199-219	8.8	18.6
8	219-261	13.0	35.4
9	261-306	8.5	9.2
10	306-349	2.9	3.8
11	Bottoms	1.4	Not determined
		100.0	

gasolines have generally been increasing along with the upward trends in octane ratings. This is the expected result from inclusion of more and more catalytically reformed and catalytically cracked gasolines in refinery outputs. There have been some combustion problems attributed to this trend. Minimizing aromatic contents at the target octane level, therefore, seems desirable.

Aromatic concentrations can be reduced by improving the nature of the non-aromatics. Figure 6 gives some measure of the extent to which this is practicable at a clear octane level of 96. Here, a 10 percent decrease in aromatic concentration can be accomplished if the quality of the non-aromatics can be improved from 50 to 65 F-1 clear octane. This effect has been of importance in our approach to the problem of an improved catalytic reforming process.

The considerations previously discussed have led our research staff to the conviction that efficient reforming to super-octane levels can be accomplished only by selective treatment of the low octane paraffins. The process to accomplish this requires a partial conversion of such paraffins under mild conditions to maintain a proper balance between the reactions of hydrocracking and dehydrocyclization without undesirable side reactions which produce excessive quantities of gas and coke. This partial conversion of paraffins requires in turn the continuous separation and recycles of unconverted material to the reaction zone.

The application of liquid-liquid solvent extraction techniques was found to be appropriate, after consideration of alternate separation methods. It developed that by careful selection of solvent and operating conditions, it is practical to selectively dissolve all types of high octane materials, both the aromatics and the low boiling non-aromatics. At the same time the high boiling low octane components are rejected by the solvent. Figure 7 illustrates the relationships involved for a solvent which may be used to dissolve all gasoline boiling range aromatics along with the low boiling, high octane paraffins and naphthenes. The use of such a solvent permits separation of reactor effluents into a super-octane portion and a low octane stream. This latter material is then available for selective

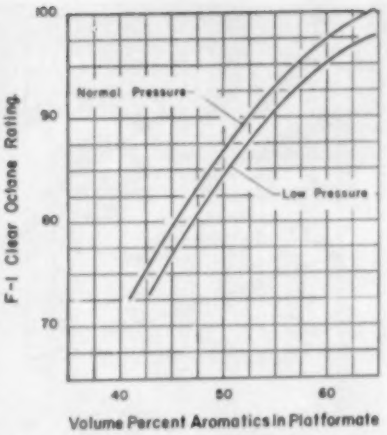


Figure 5. Platformates from Midcontinent naphtha: How operating pressure affects aromatic content.

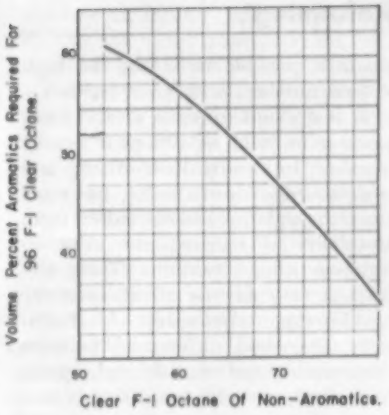


Figure 6. Improvement of non-aromatics makes a reduction in aromatic concentration possible.

upgrading to high octane gasoline, or for special uses such as a refined jet fuel component or paraffinic solvent.

The low octane stream may be handled in a separate catalytic reforming section, however experiments in completely integrated laboratory and pilot plant units proved that recycle of this material to the catalyst in admixture with raw feed is completely practical. Such operations are characterized by low recycle ratios and high liquid recoveries of very high octane gasolines. The established advantages of recycle operations, with their lower conversions per pass are well known to the refining industry. The operating conditions used in Rexforming are distinctly less severe than for conventional once-through operations.

Discussion of Results—A substantial number of runs have been made in completely integrated Rex-

TABLE 2
Laboratory Rexforming Data Midcontinent Feed Stock

Test No.	Charge	1	2
Inspections of Rexformate*			
Gravity, °API	52.5	44.3	37.2
F-1 Clear Octane	30.0	95.2	101.8†
Aromatics, Volume Percent	8	56	77
100 Ml. Distillation			
I.B.P., °F.	248	124	120
5 Percent	264	162	160
10 Percent	270	180	189
30 Percent	289	249	288
50 Percent	**312**	**297**	**326**
70 Percent	340	339	353
90 Percent	370	382	392
95 Percent	379	402	413
End Point, °F.	390	426	429
Yields			
Separator Gas, scf/bbl.	....	856	1090
Debutanizer Gas, scf/bbl.	....	246	296
Debutanized Rexformate, Volume Percent	....	82.9	76.8
10 lb. RVP Rexformate, Volume Percent	....	92.3	85.0

* Debutanized. † C.R.C. Octane scale extension.

forming units, both on laboratory and pilot plant scale. The operation of the reforming section determines the composition of the charging stock for the extraction section, while the operation of the extraction section determines the composition of the charging stock to the reforming section. Thus, it can readily be seen that complete integration and uniform continuous operation is essential to obtaining reproducible and accurate data.

The results, shown in Table 2, were obtained in Rexforming a Midcontinent naphtha in a laboratory unit. The octane number range covered by these tests is from about 95 to 102 F-1 clear. The aromatic contents of the Rexformates corresponding to these octane numbers range from 56 to 77 percent, and, as one might expect, the lower boiling fraction contains the higher octane paraffinic components, while the higher boiling fraction is essentially completely aromatic.

One of the most interesting features of these Rexforming runs is the relatively low severity required for the production of these octane numbers. For example, both tests in Table 2 were run at the same temperature level. This temperature was more than 50 F. lower than would be required for once-through operation to the lower product octane number shown. In addition, space velocities utilized were higher on the basis of fresh feed than those ordinarily employed for once-through operations at considerably lower octane levels. The combination of the mild processing conditions and selective extraction

made it possible to attain the high octane numbers with good yields.

It is difficult to make a valid comparison in yield at 100 clear octane number between Rexforming and once-through operations, because once-through operations suffer from instability at the requisite very severe operating conditions. These also have a very adverse effect upon the yield-octane relationship. Undoubtedly, the yield differential between Rexforming and once-through operations increases with increasing octane numbers.

Table 3 shows the results obtained in processing a highly paraffinic naphtha. This charging stock was deliberately selected to demonstrate the versatility of Rexforming. Product of over 100 clear octane was produced from this, the highest paraffin content (85 percent) naphtha that we have been able to locate without going to synthetic materials. The yield of the high octane number fuel is less than that obtained from the Midcontinent naphtha, which is to be expected in

TABLE 3
Laboratory Rexforming Data Low Naphthene Feed

	Charge	Rexformate
Inspections		
Gravity, °API	59.6	47.1
F-1 Clear Octane	10.3	101.0
Naphthenes, Volume Percent	12	
Aromatics, Volume Percent	2	59.2
100 Ml. Distillation		
I.B.P., °F	254	110
5 Percent	265	153
10 Percent	268	167
30 Percent	282	230
50 Percent	296	278
70 Percent	320	306
90 Percent	351	345
95 Percent	365	364
End Point, °F	396	415
Yields		
Separator Gas, scf/bbl.		940
Debutanizer Gas, scf/bbl.		484
Debutanized Reformate, Volume Percent		68.2
10 lb. RVP Reformate, Volume Percent		74.3

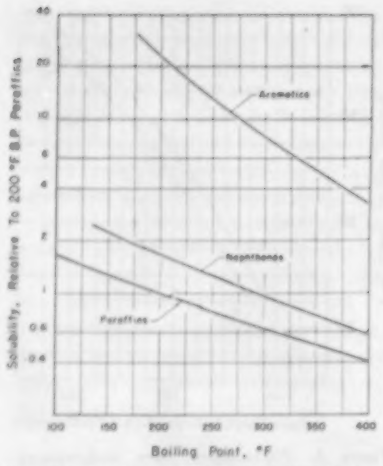


Figure 7. Relative solubilities of various hydrocarbon types: The key to the extraction step.

view of the considerably higher paraffinicity of the charging stock.

Table 4 shows the properties of the various streams obtained in Rexforming pilot plant operation. These data were obtained on a Midcontinent naphtha feed. The most important point is the relatively low octane number of the reactor effluent, indicating that a very mild reaction severity was utilized. A 41 octane number recycle stream was separated from the reactor effluent and recycled to commingle with fresh feed. Thus, the feed to the reactor was increased by about 40 percent. Since a higher space velocity was used in this case, less catalyst was actually required than for conventional once-through operations. The overall result is shown in the last column, where the product is of good volatility characteristics, has a clear octane number of 97.2 and was obtained in a yield of 80.5 percent by volume. Although in this particular operation the low octane stream was completely recycled, all or a portion of this material may be withdrawn as a net product. Due to the facts that this stream is essentially free of such materials as olefins and sulfur compounds, and in addition contains more than 90 percent paraffinic hydrocarbons, it is ideally suited for inclusion in such valuable specialty products as jet fuels, which are of growing volume in refinery production schedules.

Economics of Rexforming—The approximate investment and operating costs for Rexforming are given in Table 5 on the basis of charging 5000 barrels per stream day of full boiling Midcontinent straight-run gasoline and producing 101 F-1 clear Rexformate in a flow as outlined in Figure 1.

It is thus estimated that the Rexforming process for this type of operation costs about $300 per barrel to install and about 36 cents per barrel to operate including the costs itemized in Table 5. These are reasonable costs when it is considered that the product is of such high quality. No valid cost comparison with established once-through operations can be made at this high octane level. It should be pointed out, however, that the increased yield from Rexforming makes this process economically attractive even at the lower octane levels at which real comparisons can be made. In some cases the economics of Rexforming can be further improved by diverting the highly paraffinic recycle to jet fuel uses.

This article is condensed from a discussion presented at the Annual Meeting of the Western Petroleum Refiners Association, March 28-30, 1955, San Antonio. ##

TABLE 4
Pilot Plant Rexforming Data Midcontinent Feed Stock

	Fresh Charge	Rerun Bottoms	Combined Feed	Stabilized Reactor Effluent	Low Octane Recycle	Debutanized Rexformate
Inspection Data						
Gravity, °API	52.3	29.5	56.1	52.4	63.4	47.0
F-1 Clear Octane	33.0	....	....	76.3	41.0	97.2
Aromatics, Volume Percent	9	....	....	37.5	8.5	53.5
100 Ml. Distillation						
I.B.P., °F	242	417	166	133	114	93
5 Percent	250	431	227	172	148	109
10 Percent	264	436	241	194	165	121
30 Percent	292	....	271	245	225	173
50 Percent	316	....	298	280	266	262
70 Percent	346	....	332	313	300	309
90 Percent	374	....	367	366	355	367
95 Percent	384	....	376	387	378	393
End Point, °F	415	....	395	424	420	424
Quantities, Volumes per 100 Volumes Net Feed	101.4	1.4	144.6	125.1	44.6	80.5

TABLE 5
Estimated Investment and Operating Costs for Rexforming

Basis: 5000 barrels per stream day Midcontinent Full Boiling Straight-Run Gasoline* Producing 101 F-1 Clear Rexformate (See Figure 1).

Total Erected Cost (Within Battery Limits)	$1,600,000
Operating Costs Cents/bbl. Full Boiling Gasoline	
Operating Labor @ $2.75 per hour	4.0
Laboratory	1.0
Utilities	
Fuel @ 15¢/Mm Btu.	7.3
Power @ 0.8¢/kwh.	4.0
Steam @ 30¢/M lb.	4.6
Water @ 1¢/M gallons	1.4
Catalyst	6.9
Solvent	1.7
Maintenance @ 3% of investment per year (Labor and Materials)	2.8
Insurance and Property Taxes @ 2% of investment per year	1.9
Total Operating Costs—excluding Royalty, Depreciation, Administration and Overhead	35.6

* 4300 bbl fresh naphtha charge to reactor section.

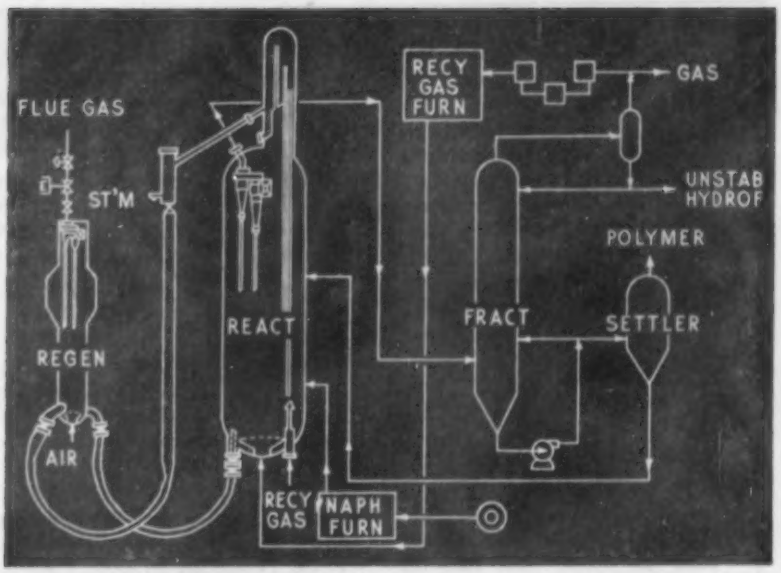


Figure 1. Process flow at the Destrehan Fluid Hydroformer: No process changes needed to increase charge rates.

Destrehan Fluid Hydroformer Today

- **Complete description includes operating data and yields from extensive testing.**
- **Special equipment has been added to the original design based on operating experience.**

R. D. Ferrell, J. R. Tusson and H. A. Parker
Pan-Am Southern Corporation, New Orleans

SINCE THE WORLD'S first commercial Fluid Hydroformer (Pan-Am Southern, Destrehan, La., refinery) was put in operation in June, 1953, the unit has been tested for a wide range of process variables. These tests have now shown that gasoline yield, catalyst activity, catalyst activity maintenance, and low catalyst attrition rates predicted from pilot plant work have been either equaled or surpassed in commercial operation.

Process Description

Oil Flow—Figure 1 shows a simplified flow diagram of the unit. Vaporized naphtha feed enters the reactor just above the recycle gas distribution grid. The feed, plus recycle gas pass upward through the catalyst bed. The upward passage of recycle gas and vaporized feed keep the catalyst in a fluidized state. The reaction products, recycle gas, and entrained catalyst pass through a dilute catalyst phase near the top of the reactor and enter a set of two-stage cyclones. Most of the entrained catalyst is separated and returned through diplegs to the catalyst bed. The effluent from the reactor cyclones passes through two inline heat exchangers. The first exchange is to cold recycle gas, the second to cold naphtha feed.

From the exchangers, the cooled reactor effluent passes into the fractionator. The heavier oil is condensed out as the vapors pass upward through the baffled section of the fractionator, which is refluxed with heavy oil-catalyst slurry. The catalyst that has been entrained into the fractionator is flushed into the heavier bottom oil. The gasoline and gas products pass overhead and through a condenser into an accumulator drum. Here, the liquid products and gases are separated. Part of the gasoline goes to a stabilizer (not shown) for removal of light hydrocarbons. Top reflux to the fractionator accounts for the balance of the stream. The gas stream from the accumulator drum is split to provide recycle gas, rich in hydrogen, for return to the reactor with the net gas passing through an absorber (not shown) counter current to fresh feed. Heavier hydrocarbons in the gas stream are absorbed into the feed and dissolved oxygen is stripped from the feed by the recycle gas.

Fractionator Bottoms—Heavy oil and catalyst are withdrawn as slurry from the bottom of the fractionator. This stream is split to become the heavy oil reflux to the bottom section of the fractionator. The remainder of the stream passes to a slurry settler. Concentrated slurry from the bottom of the settler is returned to the dilute catalyst phase of the reactor. Decanted heavy oil, or polymer, is withdrawn from the top of the settler.

Catalyst Flow—Carbon is a reaction product and deposits on the catalyst in the reactor. Carbon bearing or spent catalyst is continuously withdrawn from the reactor for subsequent regeneration. The spent catalyst passes upward through an internal spent catalyst riser to the hopper on top of the reactor. From the hopper, the catalyst flows through an inline catalyst stripper, where hydrocarbons and hydrogen are stripped from the catalyst. The catalyst then flows through a vertical standpipe, through a U-bend and into the regenerator. Regenerated catalyst flows through a U-bend transfer line back into the reactor.

Catalyst Regeneration—The spent catalyst entering the regenerator contains sufficient heat for spontaneous combustion to occur. Combustion air enters the regenerator through a distribution grid at its base and burns the carbon from the catalyst as it passes upward through the catalyst bed. The air also serves to fluidize the catalyst, which is necessary for good regeneration and flow back to the re-

actor. The regenerator flue gas, containing entrained catalyst passes through a dilute catalyst phase and disengaging space, then enters a set of two-stage cyclones. Separated catalyst is returned to the regenerator bed through diplegs. Regenerator flue gas containing a small amount of very fine catalyst passes to the atmosphere.

Process Control

Pressure—The reactor and regenerator operate with constant differential pressure. This is accomplished by reset of the regenerator pressure control index with changes in reactor-regenerator differential pressure. The regenerator pressure control valve is a single port slide valve. Reactor pressure is controlled downstream of the fractionator on the fractionator accumulator drum. This method of control allows pressure regulation downstream of all catalyst-bearing streams, thereby eliminating troublesome and expensive controller erosion.

Catalyst Circulation Control—Basic control of catalyst circulation rate is accomplished by means of a spent catalyst riser plug valve. This plug valve contains a hollow stem and plug through which recycle gas flows into the spent catalyst riser. The opening of the plug valve, together with the gas flow rate established through the valve and into the riser determine the amount of catalyst lifted through the spent catalyst riser into the hopper atop the reactor. This type riser plug valve is a feature of The M. W. Kellogg Company's Ortho-Flow type Fluid catalytic cracking units and was adapted by them for use in the Fluid Hydroformer.

The spent catalyst hopper level controls positioning of the spent catalyst slide valve.

The regenerator level controls positioning of the regenerated catalyst slide valve, maintaining constant regenerator level. The regenerator is also equipped with optional reset of level control index by temperature change.

Regenerator Waste Heat Boiler—The regeneration of spent catalyst produces excess heat other than that amount transferred to the reactor with regenerated catalyst. The regenerator waste heat boiler provided to remove this heat is a thermal syphon type. Boiler feed water flows from the boiler drum into the bottom boiler tube ring header. As the water enters the vertical boiler tubes within the catalyst bed, steam is formed. Steam is collected from the top ring header and flows into the top of the boiler drum. Saturated 200-psig steam is withdrawn from the top of the boiler on pressure control. About 2500-3000 pounds of steam per hour are produced and admitted to the refinery steam system.

Types of Operation

Thus far, operations have been largely confined to the production of motor gasoline hydroformate, since this operation has best suited refinery requirements. Aviation gasoline base stock has been prepared and has met specifications for blending into aviation gasoline just as it was produced from the unit. One other function of the Hydroformer would be production of reformate with high aromatics content—benzene, xylene, and toluene.

Motor Gasoline Operations—The virgin naphtha normally fed to the Hydroformer is fractionated essentially from Gulf Coast crudes; sulfur content of the feed is about 0.02 weight percent. Shown below is a typical inspection of the charge stock.

Gravity, ° API	52.1
Reid Vapor Pressure, psia	1.0
Octane No., CFR-R Clear	50.0
ASTM Distillation	
IBP, °F.	180
10%, °F.	255
50%, °F.	302
90%, °F.	345
EP, °F.	371

The naphthene content (naph-

Meet the Authors

H. A. PARKER is a technical director at the Pan-Am Southern refinery at Destrehan. A chemical-engineering graduate from Cornell University, Parker was employed with Standard Oil Company (Indiana) as a process engineer shortly after he left college in 1944 and in 1946, was promoted to group leader in the Process Design section. He became associated with Pan-Am Southern in 1951. He, like Tusson, is a member of both AIChE and ACS.

Parker

R. D. FERRELL, a process engineer with Pan-Am Southern Corporation since 1952, has been engaged in process work on the Hydroformer at the Destrehan refinery since it went into operation. Ferrell, a graduate in chemical engineering from Purdue University, worked as a chemical operator with Carbide & Carbon Chemicals Corporation before he started to college. Before joining the Pan-Am Southern organization, he was connected with The Champion Paper & Fiber Company for three years.

Ferrell

JOHN R. TUSSON, chief process engineer for Pan-Am Southern Corporation at its Destrehan, La., refinery, joined Standard Oil Company (Indiana) in 1947 as a process engineer at its Whiting, Ind., Research department laboratory. Three years later he was transferred to Pan-Am Southern as senior staff engineer at New Orleans, and from there he was assigned to the Destrehan refinery. Tusson holds bachelor's and master's degrees in chemical engineering from Tulane and Princeton universities, respectively. In addition to service with the Indiana group, Tusson worked with the Tennessee Valley Authority at Wilson Dam, Ala., as assistant project engineer in the Research department.

Tusson

thenes are most easily reformed) is about 35 percent.

Some limited amount of operation has been performed with inclusion of 10-20 percent cokestill naphtha in the feed. Indications were that a liquid yield loss of one to two percent was incurred; otherwise operations were essentially the same as with prefractionated virgin naphtha.

Operating Conditions

The wide range of process variables that have been employed has demonstrated the flexibility of the process in meeting changing refinery requirements. The design feed rate was 2000 barrels per day, but feed rates of 1100 to 2900 barrels per day have been used during special tests and when refinery needs necessitated such contingencies. Catalyst inventory has been varied from about 60 to 115 percent of design. These extreme variations have been possible without operational difficulties arising. Reactor temperature has been varied from 885 F. to 946 F., as compared to design of 930 F.

Shown in Table 1 are the essential operating conditions in use when operating at two extremes—(1) for production of 84 octane C_5 plus motor gasoline, and (2) for production of 96 octane C_5 plus motor gasoline. In both cases, octane numbers are on a research method rating, clear.

Relatively mild severity is shown for Case I. Reactor temperature is 39 F. below that shown for Case II. Weight space velocity, which is the ratio of pounds of oil feed per hour per pound of catalyst in the reactor, was high for Case I.

This value is a relative inverse measure of the amount of time that the oil is in the reaction zone. Reactor pressure is considerably below design of 250 psig. Since early operations, the practice has been to operate at or near 200 psig reactor temperature. No harmful process effects are incurred. Reducing system pressure has

Table 1

	Case I 84 Octane Gasoline	Case II 96 Octane Gasoline
Reactor Temperature, °F	890	929
Reactor Pressure, psig	205	200
Naphtha Preheat, °F	916	900
Recycle Gas Preheat, °F	1080	1138
Weight Space Velocity, Wo/Hr/Wc	0.52	0.30
Catalyst-to-Oil Ratio	1.13	0.87
Recycle Gas, scf per barrel Fresh Feed	5700	9950
Recycle Gas Quality, Mol % H_2	56	54
Catalyst Regeneration, °F	1100	1100
Regenerator Pressure, psig	223	215

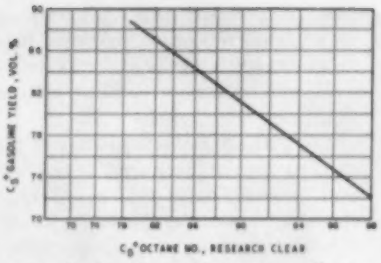


Figure 2. Gasoline yield based on 31 controlled test periods.

reduced maintenance of slide valve packing, pump packing, etc., in addition to providing more excess combustion air capacity for emergency use. In Case II considerably more than the design recycle gas ratio of 6000 standard cubic feet per barrel was used. This was done to increase reactor temperature, since the increased reactor temperature more than offset the slight lessening of severity of reaction brought about by high gas recycling rates.

Regeneration temperature in both cases is maintained at 1100 F., which is design temperature. This allows a maximum of heat to be returned to the reactor with regenerated catalyst while staying well below the temperature at which thermal degradation of the catalyst would occur.

Gasoline Yields—A plot of C_5 plus gasoline yield versus octane is shown in Figure 2. The Reid Vapor Pressure

Table 2

HYDROFORMATE PRODUCT INSPECTION

Gravity, °API	Case I	Case II
Gravity, °API	49.6	42.2
Reid Vapor Pressure	6.1	3.7
Octane No. F-1 Clear	84.0	96.0
Distillation:		
IBP, °F	118	125
10 percent, °F	181	194
50 percent, °F	276	286
90 percent, °F	334	356
End Point, °F	419	431

Table 3

Reactor Temperature, F	946
Reactor Pressure, psig	208
Weight Space Velocity, Wo/Hr/Wc	0.33
Catalyst to-Oil Ratio, Lb/Hr/Lb	0.99
Recycle Gas, SCF/Barrel Fresh Feed	7,860
Recycle Gas Quality, Mol % H_2	56
Regeneration, Temperature, F	1,040
Regenerator Pressure, psig	222

Table 4

	Test I	Test II
C_5 Plus Gasoline, Volume Percent	73.8	73.4
Total Butanes, Volume Percent	5.2	5.1
Dry Gas (C_3 and lighter), Vol. %	15.8	16.4
Carbon Burned, Weight Percent	0.77	0.78
C_5 Plus Gasoline Octane No., Research Clear	98.1	97.6

of the gasoline averages about 3 psi. The yield of 84 octane gasoline from Case I is 85.7 percent. For the second case, the 96 octane gasoline yield is 74.5 percent. At design octane of 95, the gasoline yield is 76 percent, as compared to design expectations of 74 percent. This yield curve, together with other process results have been determined in 31 carefully controlled test periods. Included in gasoline yields shown is a small amount, 2 percent, or less, of high boiling polymer.

Butane—Butane is produced in quantities ranging from 5 volume percent at 82 octane product to about 7 volume percent at 95 octane.

Dry Gas—With the exception of carbon, C_3 minus dry gas, including hydrogen, constitutes the balance of the yield.

Typical liquid product inspections corresponding to the operating conditions shown in Case I and Case II are shown in Table 2.

The product inspections shown include polymer blended with hydroformate in the proportions that they were produced.

Aviation Gasoline Operation—Operations for production of aviation gasoline base stock are similar to those used to produce high octane motor gasoline. However, the low end-point specification of 338 F. of the av-gas necessitates use of a narrower boiling range feed stock. Other specifications of the feed, however, are essentially the same as those required for motor gasoline operation.

Operating conditions for av-gas production are similar to those employed for high intensity motor gasoline production. Summarized in Table 3 are typical conditions.

The only process variable that has been materially changed from motor gasoline operating conditions is reactor temperature. Regeneration temperature is somewhat lower; however, this was a result of reduced carbon production on the lower end-point feed.

The yield of aviation gasoline from two periods of operation is shown in Table 4, together with the balance of the product distribution. The gasoline yield is in good agreement with the yield curve on motor gasoline operations presented in Figure 2.

Feed and Product Quality—Inspections of the feed stock and aviation

hydroformate are presented in Table 5. It will be noted that the hydroformate meets specifications for inclusion in aviation gasoline just as it was produced from the unit.

Catalyst Performance

The original catalyst used in the Hydroformer was for scrubout purposes only. Therefore, new catalyst was not used; catalyst from a fixed-bed Hydroformer was ground for charging to the unit. This catalyst proved useful in that considerable unit operational experience was gained; however, overall operational characteristics and process results were poor. Operations on ground catalyst were therefore terminated. Subsequent operations of the unit have been performed using catalyst manufactured to the design catalyst specifications of the unit.

Based on pilot plant studies, attrition of catalyst, or production of particles smaller than 20 microns, was expected to be between 200 and 400 pounds per day. In order to maintain uniform particle size distribution this fine catalyst is rejected. Economic studies showed that losses up to 400 pounds per day, in the case of the 2000 barrels per day Destrehan unit, or 0.2 pound per barrel of fresh feed, would be feasible. Fortunately unit attrition and consequently catalyst losses have been 110-120 pounds per day, or 0.06 pound per barrel of feed at 2000 barrels per day. Table 6 shows a typical particle size distribution of catalyst that has reached equilibrium in the unit.

This particle-size distribution is well within the specified range of not more than 5 percent 0-20 micron particles, 10-25 percent 0-40 micron particles, and a 35 percent maximum of particles greater than 80 microns. Catalyst with disproportionate amounts of either fine or coarse particles have fluidized poorly and deaerated rapidly, with resultant poor catalyst circulation.

The 110-120 pounds per day of fine catalyst that is produced is continuously rejected with flue gas through the single two-stage cyclone in the regenerator. Before installing cyclones in the regenerator, filters were used to separate catalyst entrained with the flue gas. The presently installed cyclones are preferred.

Table 5

	Feed	Hydroformate
Gravity, °API	50.0	42.9
Reid Vapor Pressure, psia	.....	4.4
Octane No.		
F-1 Clear	53.6	98.2
F-1 + 3cc TEL	73.9	.....
Performance No.		
F-3 + 3cc TEL	.....	83.5
F-4 + 3cc TEL	.....	153
Distillation		
IBP, F.	220	110
10 percent, F.	243	195
50 percent, F.	252	262
90 percent, F.	265	292
End Point, F.	293	333

Special Equipment

The original design of the Destrehan Hydroformer included several features that were either designed for or adapted to Fluid Hydroforming. Operational experience and process performance showed that some revisions were desirable. Also, some further additions of equipment were made. The following is a discussion of the more important items of special equipment.

Catalyst Transfer U-Bends—Both spent and regenerated catalyst flow through U-Bends, as shown in Figure 1. This type of catalyst transfer was developed by the Standard Oil Development Company, for use in several types of fluid-solids processes. The main advantage of the U-bends is lower unit profile, that materially reduces investment costs. This is possible since dense phase catalyst flow through the U-bend forms a catalyst seal. Earlier model fluid-solids units utilized long standpipes for sealing catalyst transfer lines. To accommodate these long standpipes the unit structure was necessarily quite high. The catalyst seal is necessary because the catalyst travels from a hydrogen-rich gas atmosphere in the reactor to an air atmosphere in the regenerator. The original design of the Destrehan Hydroformer did not incorporate a spent catalyst U-bend, but modification after startup was made to include a U-bend in that system.

Catalyst Transfer Line Block Valves—Catalyst flow through the spent and regenerated transfer lines is regulated by a slide valve in each line. Since these valves are subject to erosion, separate block valves are provided. One valve is located just under the spent catalyst stripper. The other two valves are at the regenerator outlet and reactor inlet, in the regenerated catalyst line. All of these valves are equipped for remote operation from the process control panel.

Table 6

Particle Size, Microns	Weight Percent
0-20	1
20-40	13
40-80	59
80+	27

Recorders—Catalyst Transfer—Both catalyst transfer lines are equipped with rapid temperature instruments that record six temperature points each four seconds. If a hot-spot occurs, visual and audible signals are actuated. Observation of the temperatures recorded also provides an excellent secondary method of determining the smoothness of catalyst circulation.

Flue Gas Shut Off Valve—The regenerator flue gas line contains a remotely operated shut off valve. This valve is provided for instantaneous "bottling in" of regenerator pressure in the event that the combustion air compressor fails. This allows operational time necessary to switch to an alternate pressure supply and prevents surging of catalyst into a depressured regenerator.

Trickle Valves—The cyclones in both regenerator and reactor are equipped with trickle valves. These valves eliminate the necessity of sealing the diplegs in the catalyst beds, that would require much higher vessels. The diplegs terminate just above the dense catalyst phase. The trickle valves therefore operate in a dilute phase rather than a dense phase.

The valve is hinged so that the flapper hangs vertically. The valve exit is a few degrees off vertical so that when not in use the flapper hangs slightly open. The downward flow of catalyst removed in the cyclones creates sufficient head to open the valve. Sudden increases in velocity from the catalyst bed would cause the valve to close, preventing loss of catalyst by back flow through the dipleg. The trickle valves have thus far required no maintenance.

At the present time unit tests are in progress that will become the design basis for resizing controllers, etc., to permit higher throughput rates. No process changes will be required to permit increased charge rates. The unit will still retain the flexibility necessary for lower throughput-high intensity operations. ##

Close-up shows how rubberized asphalt holds coarse aggregate to the base.

What's New in Asphalts

Research produced a practical means of rubberizing asphalts for improved highway constructions.

Walter F. Winters,
Rubarite, Inc.,
Chicago

RESEARCH PRODUCES a practical means of rubberizing asphalts for improved highway construction.

With new highway construction getting so much attention from the federal government lately, the asphalt picture is looking up quantity-wise. Refiners are also giving it another look quality-wise. Asphalt made secondary roads feasible; it is now being used in many of the heaviest traveled highways of the country, e.g., the New Jersey turnpike.

Asphalt as derived from crude oil is made into many different grades and types but basically, as a binding material it must serve as nature made it. This condition imposes some limitations on the material. For example, there may be a softening of asphalt during hot weather, on the other hand low temperatures may cause a hardness which will lead to cracking. These and other characteristics have been reviewed more extensively recently in an effort to change the basic material.

It has long been known that certain rubbers when properly dispersed in asphalt cause some startling changes, but many problems faced the researchers. First, the rubber had to be available in a practical form, that is it had to be a powder or liquid that could be stored for long periods without change, it also had to be a material that could be easily handled and used. To be a practical material, it had to be in a form in which the road contractor could use it on the job by adding to the hot asphaltic mix or it had to have the capacity of simple mixing with asphalt at the refinery.

Second, but perhaps most important, it had to be compatible with asphalt and be of such form it could be easily and thoroughly dispersed in the asphalt. With these thoughts in mind, research scientists from Goodyear Tire and Rubber Company, The Baroid Division of National Lead Company and Berry Asphalt Company tackled the problem.

In the first place it was known that rubber particles to be quickly affected by the heat and agitation of asphaltic mixing had to be very small in size. It was also known the rubber had to be in a raw state as a vulcanized rubber is hardened and very difficult to

Seal coat project: An economical treatment if the asphalt is right.

"melt down." Next, a compatible rubber was needed which could go into solution in the asphalt, perhaps so completely that the internal structure of asphalt would be changed.

The last problem was solved first and after many trials, butadiene-styrene synthetic rubber (GRS-II) which is made from petroleum was selected. Naturally a synthetic rubber made from the same mother material as asphalt would have a high degree of affinity for that material. Barytes was selected as the vehicle for carrying and over-coming the stickiness of the raw rubber as it was necessary to have the powder in free-flowing form. Barytes also has another peculiarity as far as asphalt is concerned; it has a preferential "wetting" ability in that material. After considerable study a process was developed for combining GRS-II rubber and barytes into a fine-grained, free-flowing powder. The raw rubber particles being approximately one micron in size and the barytes from five to ten micron. Thus an asphalt rubberizer was developed.

This material accomplishes some unusual results when mixed with asphalt. When as little as 10 percent is mixed with certain paving grade asphalts the tendency to soften or cold flow at high temperatures is often reduced to one-half, this means less pushing and shoving of pavements in the summertime. The flexibility or ductility of asphalts during cold weather is increased in some cases by as much as 100 percent. The strength or toughness of the asphalt is increased eight to ten times and the adhesion is materially increased. These improvements all point to increased life, reduced maintenance costs and pavement failures.

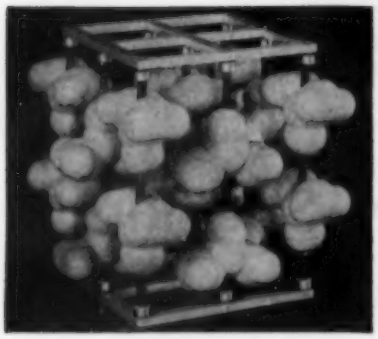
Some deficiencies such as the cracking which occurs at times on asphaltic overlays or resurfacing of cement concrete pavements where the cracks from the concrete pavements "come thru" the asphalt resurface are also reduced materially. For example, a rubberized asphalt resurfacing project in Rapid City, S. D., showed about 1/10 of the cracking as compared with a similar resurface job without rubber after having gone thru a typical South Dakota winter. Other improvements are noted in this type of work, e.g. the unusual strength and adhesion of the rubberized asphalt allows the use of somewhat inferior stone or gravel, thereby saving considerable road funds as these materials are often available near a project. Relatively thin courses of resurfacing, such as feather-edging tend to stick and last longer. This type of construction is often necessary on city streets where grades change rapidly at intersections. A rubber job on 92nd Street in Chicago which was feather-edged on brick pavement stayed in place where an adjacent lane of regular asphaltic mix "peeled back." Probably the greatest contribution of petroleum rubber to asphalt pavements is additional strength and "stickiness."

A type of asphaltic construction in common use today are relatively thin, economical treatments called seal coats, light surface treatments or penetration jobs. In this work a thin film of asphalt is spread all over the pavement to be treated and a thin coat of stone or gravel is spread over it and rolled in place. In many locations at certain times of years, those projects are not too successful as the asphalt quickly chills and the stone fails to stick. Rubberized seal coat projects in Maine, New Hampshire, Minnesota, Tennessee, Mississippi, Wisconsin, South Dakota, Missouri, Arkansas, Washington and many other states have shown excellent results regardless of difficult construction conditions.

There are many other applications for petroleum rubberized asphalts in highway construction such as rubberized expansion joints, rubberized asphalt membranes, bridge seals, etc., that furnish further improvement to the construction. ##

Meet the Author

WALTER F. WINTERS, general manager of Rubarite Corporation in Chicago, has completed more than 28 years of active and reserve duty in the Army. After World War II, he joined the Asphalt Institute as special projects engineer at Denver, Colo., and was promoted to chief engineer in 1950. He left the Institute to join Rubarite in 1953. A graduate of Washington State University, Col. Winters spent more than 25 years in highway engineering at city, county and state levels. Much of his experience was as district and division engineer for the Washington State Highway Department.



UREA COMPLEXES

A symposium on a new separation tool—extractive crystallization.

John J. McKetta
REFINER Staff

EXTRACTIVE crystallization is a new process which may soon rank with distillation as a major method of separating mixtures. This process, resulting from an accidental discovery by an alert scientist, provides the petroleum and the petrochemical industries with an entirely new tool.

Dr. M. F. Bengen, Director of a government laboratory in Frankfurt, Germany, added normal octanol and urea to milk and noticed tiny, needle-shaped crystals. He found out later that not only do straight-chained compounds form crystalline compounds with urea but equally important, that branched paraffins and other hydrocarbons do not.

The separation of normal paraffins from petroleum has always been a major problem for the petroleum industry. Immediately after Dr. Bengen's discovery numerous industrial organizations began to show a high degree of interest in this new principle. Many questions regarding this new process have been answered in the past few years. The search is still on for many more answers and some day soon a full scale process will evolve.

How can such an unreactive substance as paraffin form a compound with urea which itself is not considered overly active? Why do normal paraffins combine with urea while the branched ones do not? What are these complex compounds and how are they formed? The answers to the first two questions were answered independently by C. Hermann in Germany and, in greater detail, by A. E. Smith of Shell Development Company, both by X-ray studies.

In the presence of straight-chained compounds, urea does not crystallize in its usual tetragonal modification. It uses the straight chain as the mandrel and wraps itself around it in a helix. Together, these helices form a honeycomb structure on a molecular scale. The straight-chain mandrels fill the honeycomb channels. There is little attraction between the normal paraffin in the channel and the urea in the honeycomb wall. However, if a mandrel is available, the urea prefers the honeycomb structure and nothing but a straight-chain molecule will enter the honeycomb channels. This is a simple explanation for the selectivity of urea for the straight-chain paraffin.

In view of the great practical importance of the separation of normal paraffins, and in view of the tremendous interest shown by scientists and engineers concerning this subject, the PETROLEUM REFINER is glad to present two discussions of a recent symposium on urea complexes. These give the fundamental aspects as well as the practical applications in the petroleum industry.

In the first discussion Drs. W. G. Domask and K. A. Kobe answer your questions concerning the general properties of the urea complexes. Which substances do form complexes? What are the conditions of formation? What are the conditions of decomposition? and many other questions which naturally arise when any systematic application is attempted.

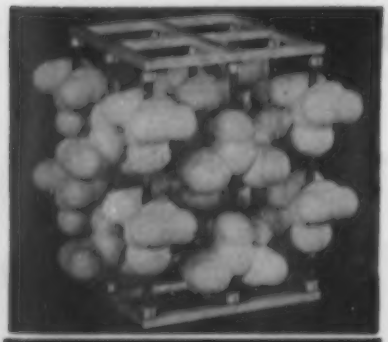
In the second article Dr. L. C. Fetterly surveys the industrial applications of this new process. Dr. Fetterly has been in the forefront in research on urea complexes, and a voluminous amount of pioneering data were uncovered because of his brilliant efforts. More than 20 patents on this subject attest to his position in this field.

Urea complexes also have a great established place in the laboratory operations for separations, purifications and analyses. Pilot plant studies are also available. Industrial applications are coming. Already some studies have shown that normal paraffins, in the heavy gasoline range and higher, can be removed economically from petroleum fractions.

Here are the details . . .

Fundamentally Speaking. Dr. W. G. Domask and Dr. K. A. Kobe 128

How They're Applied. Dr. L. C. Fetterly 134



Fundamentally Speaking

Urea Complexes

These studies on the general properties of urea and thiourea complexes show which substances do form complexes and what are the conditions of formation.

William G. Domask, Humble Oil & Refining Company, Baytown, Texas
Kenneth A. Kobe, University of Texas, Austin

THE ACCIDENTAL discovery in 1939 by Bengen[5,6,14] that urea forms crystalline complexes with straight-chain organic compounds has led to intensive investigations of the complex-forming properties of urea and its analogues in laboratories throughout the world. Since this discovery became generally known about ten years ago, Angla[1,2] and Fetterly[5,10] extended the work to thiourea complexes, and Redlich et al.[9,10], Schlenk[12,13,14], Smith[16,17] and Zimmerschied et al.[19,20] described further work on both urea and thiourea complexes. Much of the early work on these complexes has been reviewed recently.[7] In general, urea forms crystalline complexes with straight-chain compounds, and thiourea forms similar complexes with branched-chain and certain ring-type compounds; however, thiourea is not so specific as urea in its action. The crystalline complexes can be filtered and handled physically like most ordinary crystals, and they can be dissociated easily to recover the separate components. Selenourea and tellurourea also form complexes, but it appears that these materials will have only limited utility as complexing agents in the foreseeable future. Here will be considered some of the fundamental properties of urea and thiourea complexes.

Composition of Urea and Thiourea Complexes

It has been established that the cross-sectional dimensions of the lumens formed by urea and thiourea molecules, along with the spatial configuration of possible reactant molecules, largely determine whether specific complexes, or adducts, can be formed. The principal requirement for adduction with urea is a long, unbranched chain; however, some long molecules with appropriately placed methyl groups or certain terminal monocyclic groups also form adducts. The known urea complexes include paraffin hydrocarbons, ketones, organic acids, esters, olefins, halides and other substituted compounds. There is a minimum chain length required for adduct formation at a given temperature. At 25C., the minimum chain length for paraffins is six carbons; for monobasic acids, butyric acid; for alcohols, it is hexanol, and for ketones, it is acetone, the first member of the series.

The requirement for adduction with thiourea can be visualized better in terms of cross-sectional dimensions than by chemical classification. Schiessler and Flitter[11] describe the use of molecular models in predicting adductibility with thiourea. In general, urea and thiourea tend to be complementary in their selectivity. However, McLaughlin and McClenahan[8] have shown that *n*-paraffins adduct with thiourea under suitable conditions. This can be explained by the spatial concept if the paraffin chain is coiled into a multi-turn helix such that its dimensions meet the requirements for thiourea adduction.

The partners in urea and thiourea complexes are not united in whole numbered ratios except by chance. This is demonstrated in Table 1, which shows the selectivity of urea and thiourea for the compounds listed. Straight-chain olefins have slightly lower ratios of urea to reactant than the corresponding saturated compounds, because the olefin molecules are slightly shorter than the corresponding *n*-paraffins. The correlation of molal ratio with chain length for *n*-paraffins is shown in Figure 1. The calculated urea/hydrocarbon ratio *m* for *n*-paraffins is given by Equation (1), where *n* is the number of carbon atoms.

$$m = 0.6848\ (n - 1) + 2.181 \quad (1)$$

Data in the literature are in excellent agreement with this equation. Schlenk[12,13] has presented similar correlations for various classes of urea and thiourea adducts.

Properties of Urea Complexes

The urea complexes form excellent needle-type crystals. They exhibit definite vapor pressure—temperature relationships as do other types of crystals, but the complexes do not exhibit definite melting points. In the lower molecular weight range, dissociation sets in before a fixed melting point can be attained. Knight et al,[6] found that the "dissociation temperature"

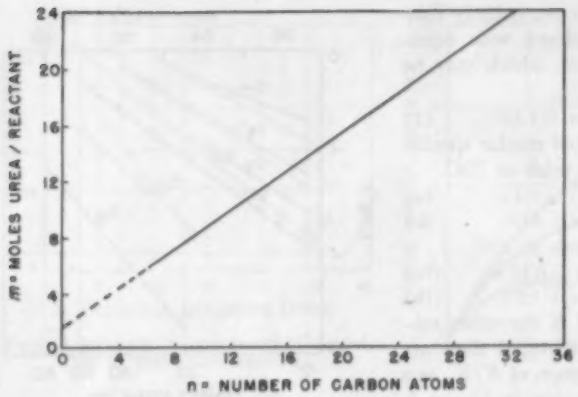


Figure 1. Relation of molal ratio m to chain length for n-paraffins.

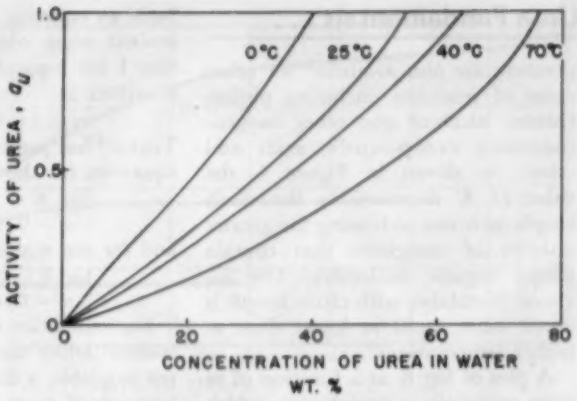


Figure 2. Activity of urea in aqueous solution ($a_u = 1$ for solid urea.)

for dry crystals is reproducible when defined in terms of the temperature at which opacity first occurs when a transparent crystal of a complex is heated slowly. Complexes which do not dissociate below 132.7C. finally dissociate at that point, which is the melting point of urea.

The density of urea adducts can be obtained experimentally with a pycnometer if precautions are used in the selection of the liquid. Also, densities can be calculated from crystallographic data and the known composition of the complexes. A comparison of calculated and experimentally determined densities[12] for several complexes is given in Table 2.

Equilibrium and Free Energy—Chemical equilibrium is established in the formation of urea complexes just as in the usual chemical reactions. In the case of n-paraffins, the equilibrium shifts toward the adduction of more reactant as the chain length increases. The data in Table 3[15] show the separations which can be effected for various two-component systems at the temperatures indicated.

The equilibrium constant K may be defined conveniently in terms of the dissociation reaction for one molecule of complex.

$$\text{Complex (s)} \rightleftharpoons \text{Reactant} + m\ \text{Urea} \qquad (2)$$

The dissociation constant for this reaction is defined in terms of the activities a of the constituents involved.

$$K = \frac{(a_r)\ (a_u)^m}{(a_c)} \qquad (3)$$

By this definition, as the value of K decreases, the stability of the complex increases.

The standard free energy change, $\triangle G^\circ$, for the reaction may be evaluated by determining the value of the equilibrium constant by one of the methods described by Redlich et al.[9] and Truter.[15] The relationship between $\triangle G^\circ$ and K is given by the well-known equation:

$$\frac{\triangle G^\circ}{T} = R \ln K \qquad (4)$$

Where equilibrium is established among a pure reactant, aqueous urea and a complex, it may be assumed that the solution is ideal. Since the reactant is present as a separate liquid phase, $a_r = 1$, and since the complex is present as a solid phase, $a_c = 1$. This leaves only the activity of urea in aqueous solution to be determined. Data for this purpose, presented by Redlich et al.,[9] are shown in Figure 2 for a sufficient range of temperatures to satisfy most requirements.

Equilibrium constants as here defined have been obtained for a number of systems.[9] The relationship between K and temperature for n-paraffins up to hexadecane is shown in Figure 3. In Figure 4, K is shown as a function of the number of carbon atoms in the n-paraffin chain at various temperatures.

Relationships between K and tem-

TABLE 2
Densities of Urea Complexes

Organic Component in Complex	Density (d_4^{20}) Calc.	Exp.
n-Dodecane	1.205	1.203
Cetane	1.208	1.200
4,4'-Dichlorodibutyl ether	1.310	1.307
Lauric acid	1.248	1.242

TABLE 1
Adduct Formation With Urea and Thiourea

REACTANT	Adducting with Urea at 25 C. Urea/Reactant Molal Ratio	Weight Ratio	Non-Adducting with Urea at 25 C.
Acetone	3.39	3.5	n-Pentane
Methyl ethyl ketone	3.76	3.15	2,2,4-Trimethylpentane
Adipic acid	5.3	2.2	3-Ethyltetracosane
n-Heptane	6.1	3.7	9-n-Butyldocosane
n-Octane	6.73	3.54	7-n-Hexyldocosane
Octene-1	6.3	3.4	1-Phenyloctane
n-Nonane	7.4	3.47	2-Phenyleicosane
n-Decane	8.1	3.4	17-Phenyltriacontane
Decene-1	7.8	3.2	1-Cyclohexyloctane
n-Hexadecane	12.0	3.2	9-Cyclohexyleicosane
Oleic acid	12.2	2.6	Benzene
Methyl stearate	14.8	3.0	Carbon tetrachloride
n-Octadecane	14.0	3.3	Methanol
n-Tetracosane (n-$C_{24}H_{50}$)	16.0	3.2	Isopropanol
n-Dotriacontane (n-$C_{32}H_{66}$)	23.3	2.1	Acetic acid

REACTANT	Adducting with Thiourea at 25 C. Thiourea/Reactant Molal Ratio	Weight Ratio	Non-Adducting with Thiourea at 25 C.
2,2-Dimethylbutane	2.6	2.3	n-Hexane
2,2,4-Trimethylpentane	3.3	3.3	n-Dodecane
2,2,4,4-Tetramethylpentane	4.0	3.6	3-Methylheptane
2,6,9,11-Tetramethyldodecane	7.9	3.6	5-n-Butylnonane
Cyclopentane	2.4	2.6	Benzene
Cyclohexane	2.0	2.7	Toluene
Cyclohexadiene-1,4	2.9	2.76	1-Phenyloctane
Methylcyclohexane	2.9	2.3	1,2-Diphenylethane
n-Hexylcyclohexane	8.9	2.7	9-Cyclohexyleicosane
1,2-Dicyclohexylethane	6.0	2.5	Tricyclohexylmethane
Carbon Tetrachloride	2.0	1.5	Methyl iodide
Cyclohexanol	3.0	2.3	Methanol
Cyclooctane	3.1	2.1	Isopropanol
Decahydronaphthalene	4.0	2.2	n-Butanol
2,6,9,12,15-Pentamethylheptadecane	11.0	2.7	Amyl acetate

perature are also available[9] for other series of reactants, including olefins, halides, alcohols and other oxygen-containing compounds, acids and esters. As shown in Figure 4, the value of K decreases as the chain length increases, indicating the greater stability of complexes that contain longer organic molecules. The increase in stability with chain length is much more rapid at lower than at higher temperatures.

A plot of log K as a function of m gives essentially a straight line which can be generalized at 25C. for many types of reactants by the equation:

$$\log K = 2.20 - 0.403\,m \qquad (5)$$

Such an equation is particularly convenient when considered with equation 1 for n-paraffins, which may be rewritten as:

$$m = 0.6848n + 1.496 \qquad (1)$$

Truter[18] has presented similar specific equations for the n-acids at 25C.

$$\log K = 1.9 - 0.4\,m \qquad (6a)$$

$$m = 0.71\,n + 1.08 \qquad (6b)$$

and for the n-alcohols at 25C.

$$\log K = 2.5 - 0.43\,m \qquad (7a)$$

$$m = 0.66\,n + 1.55 \qquad (7b)$$

For estimation of K for other substances[9] when the required data are not available, a diagram of K/K_p as a function of n, as shown in Figure 5, is useful. In this diagram, n is the number of carbon atoms, K is the equilibrium constant of the member of a homologous series, and K_p is that of the corresponding n-paraffins. The values for K/K_p approach unity with increasing values of n, as would be expected.

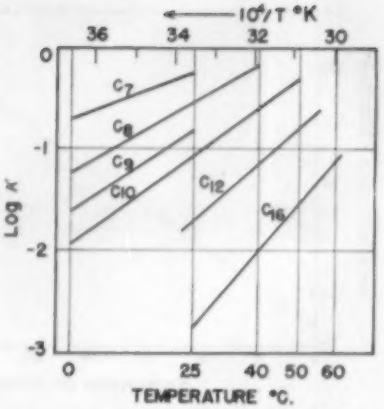


Figure 3. Equilibrium constants of n-paraffins as a function of temperature.

Heat of Formation—The formation of urea complexes is an exothermic process which exhibits a heat of reaction about the same as or greater than the heat of vaporization of the reactant molecule. Experimental values[9,20] for heats of formation of a number of complexes are given in Table 4. As would be expected, the values increase with the chain length of the reactant molecules.

The relationship between heat of formation ($\triangle H$ = kcal./g-mole at 25C.) and molal ratio m is approximately linear and has been expressed by Redlich et al.[9] as:

$$-\triangle H = -6.5 + 2.37\,m \qquad (8)$$

This is a generalized equation which serves well for normal hydrocarbons. The calculated value may be improved by changing the value of the constant to about three for acids and about eight for esters.

The relationship of K and temperature to the heat of formation is given by the van't Hoff equation:

$$R\left[\frac{\partial \ln K}{\partial (1/T)}\right]_p = -\triangle H^\circ \qquad (9)$$

This can be used in connection with Equations (1) and (5) or with plots of data as shown in Figure 3. A correlation of heat of formation data with chain length for n-paraffins is given in Figure 6.

Stability of Urea Complexes—From the equilibrium constant as defined by Equation (3), it is apparent

Meet the Authors

WILLIAM G. DOMASK is one of Dr. Kobe's graduate students at The University of Texas. Holder of bachelor's and master's degrees in chemical engineering from Texas A&M College, he is completing work on his doctorate. During World War II, Domask, a chemical officer, received the Bronze Star for his plan for gas defense which was adopted for the invasion of Normandy. After the war, he joined Jefferson Chemical Company in its research laboratories at Port Arthur, Texas. He has held the company's graduate fellowship at the university for the past two years. While a student at Texas A&M, he worked summers for Gulf Oil Corporation in its testing laboratories at Port Arthur. He is a member of Phi Lambda Upsilon (honorary chemical society) and Omega Chi Upsilon (honorary chemical engineering society) and a former president of the student chapter of AIChE at Texas A&M.

Domask

KENNETH A. KOBE is a professor of chemical engineering at The University of Texas, where he is also associate director of the Bureau of Industrial Chemistry, which is engaged in research on natural resources. Before joining the Texas faculty in 1941, he taught at the universities of Minnesota and Washington and during World War II, was an instructor at the Chemical Warfare School. A registered professional engineer in Texas, Dr. Kobe has been an industrial consultant since 1931. His industrial experience includes work with Bradley-Fitch Company on the recovery of low-grade ores in Minnesota. He was granted a patent on what is now the company's approved process. He worked for Du Pont Ammonia Corporation and National Safe Protector Company, where he obtained another patent, and was retained for three years as technical director for Manganese Products, Inc. Listed in Who's Who in America, Who's Who in Engineering and American Men of Science, Dr. Kobe is author of more than 110 published articles, several of which have appeared in the PETROLEUM REFINER.

Kobe

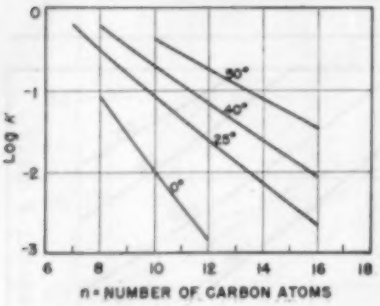


Figure 4. Influence of chain length of *n*-paraffins on equilibrium constants.

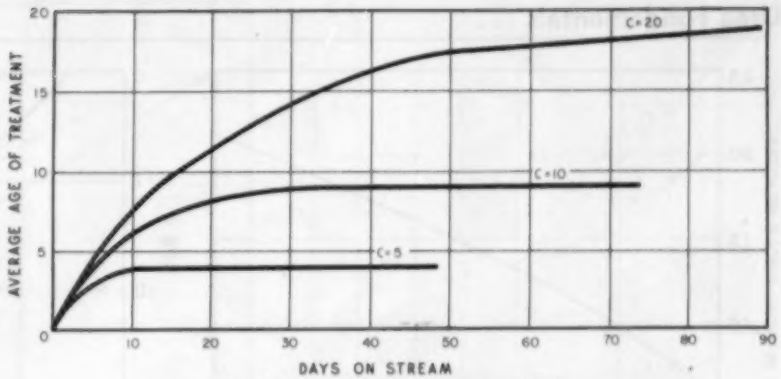


Figure 5. Generalized equilibrium constants.

that the relative stability or degree of dissociation of a urea complex in contact with water depends on the concentration of urea in the aqueous medium. Redlich et al.[9] present data that illustrate this, as shown in Figures 7 and 8. The equilibrium between *n*-paraffins in a hydrocarbon mixture and an aqueous urea solution is shown in Figure 7 for several reactants. The rapid increase of the mole fraction x of paraffins with decreasing urea concentration emphasizes the importance of maintaining urea saturation. The relative increase in stability with chain-length of the paraffins also is shown clearly.

The stability field of a *n*-paraffin complex is described by Figure 8. The top line is a saturation curve which indicates the solubility of urea in water. A complex is stable in contact with an aqueous solution if the urea concentration exceeds a certain value, "the decomposition concentration." The stability field is enclosed by the saturation line and the decomposition line. These two curves intersect at the decomposition temperature, for which $K = 1$. Above this temperature, the complex does not exist under any conditions.

Mixed Reactants—Equations and relationships considered so far have been for precipitation of a single substance. Practical applications usually involve mixtures which contain several reacting substances. Redlich et al.[9] have shown that the complex from mixed reactants is a single solid solution which can be described from the foregoing relationships if the activity of each reactant in the complex is taken equal to its mole fraction y; calculated on a urea-free basis.

In developing the relationships which apply to mixtures, consider the following definitions:

z_i = mole fraction of any individual reactant in the feed.

$$z = \Sigma z_i \qquad (10)$$

$(1 - z)$ = mole fraction of all non-reactants in the feed.

x_i = mole fraction of individual reactants in the mother liquor at equilibrium

$$x = \Sigma x_i \qquad (11)$$

y_i = mole fraction of reactants in the solid complex at equilibrium on an urea-free basis.

$$\Sigma y_i = 1 \qquad (12)$$

The equilibrium constant for mixtures is given by

$$K_i = \frac{(a_i)\ (a_u)^{\ m_i}}{y_i} = \frac{(x_i)\ (a_u)^{m_i}}{y_i} \qquad (13)$$

where the activity a_i of a reactant in the mother liquor is taken equal to its mole fraction x_i; that is, the activity coefficients γ_i defined by $a = \gamma x$) are taken as unity.

Since Equation (13) is applicable for each reactant in the mixture, it is apparent that the concentrations of individual reactants in the mother liquor can differ from the equilibrium concentrations for pure reactants. Thus it follows that from a mixture, a substance whose complex is unstable by itself ($K_i > 1$) can be precipitated in the solid solution. As a consequence, sharp separations in mixtures cannot always be obtained, but a considerable degree of enrichment can usually be achieved. This suggests that successive treatments with an insufficient amount of urea will sometimes be desirable.

The relationship in Equation (13) may be expressed at a ratio of y_i to show the degree of separation which can be realized in a binary reactant system in a solvent:

$$\frac{y_1}{y_2} = \frac{(x_1)\ (K_2)}{(x_2)\ (K_1)} a_u^{\ (m_1 - m_2)} \qquad (14)$$

If an excess of solid urea is present, $a_u = 1$, and the degree of separation is controlled by the relative values of K_i. In any other fixed binary system,

TABLE 4
Heats of Urea Complex Formation

Reactant	$-\Delta H$ kcal./g-mole
n-Heptane	7.6
n-Octane	9.7
Di-n-butyl ether	9.3
n-Decane	13.1
n-Decene-1	11.6
n-Dodecane	16.1
n-Dodecene-1	12.6
n-Hexadecane	21.0
n-Octadecene-1	23.8
Oleic acid	27.4
Methyl Oleate	25.0
n-Octanol-1	7.3
Dodecanol	11.7
n-Heptyl mercaptan	5.8
n-Dodecyl mercaptan	14.0

TABLE 3
Separation of Mixtures by Urea Complex Formation

MIXTURE	Temp. C.	COMPLEX		RAFFINATE	
		Reactant	Weight Percent	Principal Component	Weight Percent
n-hexane—iso-octane	−10	n-hexane	100	iso-octane	70
n-heptane—iso-octane	−10	n-heptane	100	iso-octane	75
n-octane—iso-octane	20	n-octane	100	iso-octane	30
n-octane—iso-octane	10	n-octane	100	iso-octane	70
n-octane—iso-octane	0	n-octane	100	iso-octane	80
n-octane—iso-octane	−10	n-octane	100	iso-octane	80
n-decane—iso-octane	−10	n-decane	100	iso-octane	94
n-decane—cyclohexane	10	n-decane	100	cyclohexane	95
n-decane—benzene	−10	n-decane	100	benzene	95
n-hexadecane—iso-octane		n-hexadecane	100	iso-octane	99

Urea Complexes

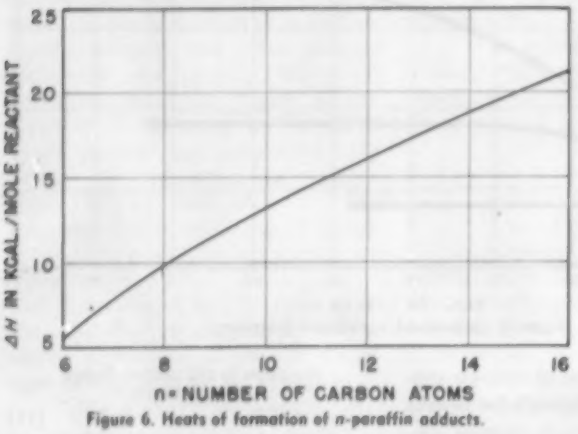


Figure 6. Heats of formation of n-paraffin adducts.

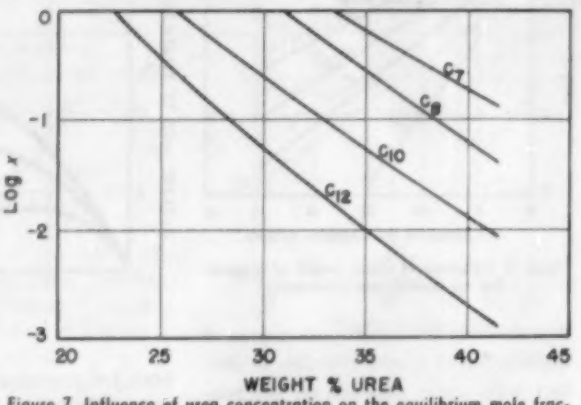


Figure 7. Influence of urea concentration on the equilibrium mole fraction (x) of n-paraffins (aqueous urea solutions at 0° C.)

the value of a_u may be controlled by the urea concentration to provide the most suitable degree of separation.

The principal problem in calculations for multicomponent reactant systems is the determination of mole fractions x_i in the mother liquor and y_i in the solid complex. The basic relationships required for a material balance of the reactants in the system are given in Equations (10), (11), and (12). To simplify the derivation, the quantities of reactants are expressed relative to one mole of nonreacting solvent $(1 - z)$ which, as it moves unchanged through the process, is the tie element in the calculations. The material balance for each component is then expressed by

$$\frac{z_i}{(1-z)} = \frac{x_i}{(1-x)} + y_i\left[\frac{z}{(1-z)} - \frac{x}{(1-x)}\right] \quad (15)$$

By eliminating y_i with Equation 11 and simplifying the last term this becomes:

$$\frac{z_i}{(1-z)} = \frac{x_i}{(1-x)} + \frac{x_i a_u}{K_i}\left[\frac{z-x}{(1-z)(1-x)}\right] \quad (16)$$

This may be rearranged and solved for x_i to give:

$$x_i = \frac{K_i z_i (1-x)}{K_i(1-z) + a_u^{n-1}(z-x)} \quad (17)$$

The individual equilibrium constants, K_i, are known or can be determined, and z and z_i are known from the analysis of the original mixture. If excess urea is present, $a_u = 1$. The problem now is reduced to the determination of x so that individual values of x_i can be calculated.

As a good approximation, the following expression may be substituted for x in Equation (17):

$$x = \frac{\Sigma z_i K_i}{z} \quad (18)$$

A graphical trial-and-error method[18] may be used to provide an exact solution. In this method, values of x are assumed, the individual values of x_i are calculated, and the results are plotted on a graph of x_i *vs.* x. The unique solution is then defined by the intersection of the calculated curve for x_i with the parity line, as described by Figure 9, which is the solution for the hypothetical mixture given in Table 5. For the data given, 87.8 mole percent C is removed from the starting mixture by the complex.

TABLE 5

Data for Demonstration of Graphical Solution of Equation (17).

Basis: 1 mole solvent
$a_u = 1$

Component	Original Mixture		K_i	Moles in Mother Liquor	Moles in Complex
	Moles	z_i			
A	0.1	0.0625	0.3	0.0454	0.0456
B	0.3	0.1875	0.2	0.1072	0.1928
C	0.2	0.1250	0.05	0.0244	0.1756
		z=0.3750			

The relationships derived from mixtures of reacting substances are restricted by the conditions that have been specified. However, these conditions will satisfy many applications, and the methods employed can be extended to other complexes.

Decomposition of Complexes—After urea complexes have been formed, the urea framework must be destroyed to recover the reactant material. In the case of volatile reactants, this can be done simply by thermal dissociation with vaporization of the reactants. Solvents provide a convenient means for complex dissociations. The possible types of solvents are (a) those which dissolve only the organic component, (b) those which dissolve only urea, and (c) those which are solvents for both.

Solvents of type (a) are generally not satisfactory for relatively stable complexes, because the degree of dissociation is usually very small. Those of type (c) often require a large volume to attain a high degree of dissociation. However, individual cases may make the use of this type desirable. Water is a solvent of type (b). It is suitable for many applications because of its relatively high temperature coefficient for urea saturation (Figure 8). Its property of immiscibility provides a convenient means for recovery of reactants.

Properties of Thiourea Complexes

As seen from Table 1, saturated ring compounds are included among reactants with thiourea, but highly unsaturated ring compounds usually do not form thiourea complexes. Some compounds which are non-adducting by themselves often can be induced to form a complex when mixed with certain adduct-formers. As reported by Schlenk,[13] different reactants exhibit different degrees of activity in this respect. Some examples of "inductors" arranged in order of decreasing activity are di-isobutylene > 2,2,4-trimethylpentane > tri-isobutylene > 2,2,3-trimethylbutane > decahydronaphthalene > cyclohexane > dicyclohexyl. Some examples of inducted compounds arranged

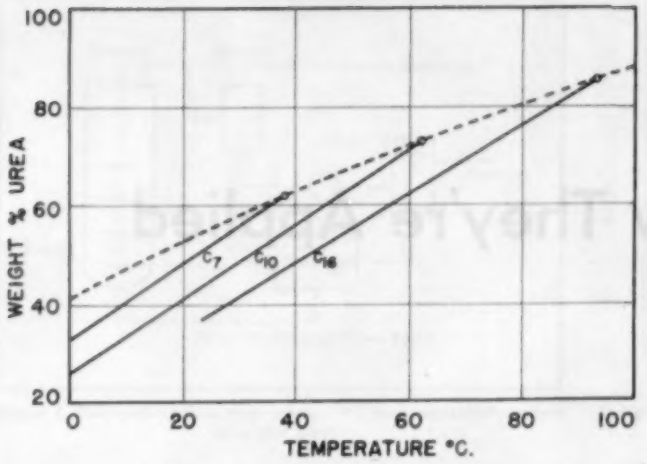


Figure 8. Stability fields of *n*-paraffins.

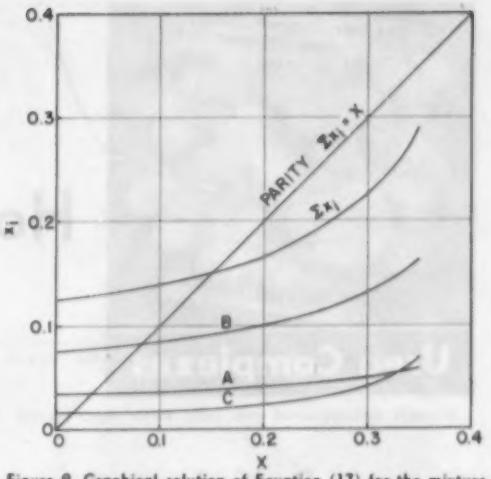


Figure 9. Graphical solution of Equation (17) for the mixture given in Table 5.

in decreasing ease of induction, include 1,3-dimethylcyclohexane > dipentene > benzene > 3-methylheptane > decane > octene-1tane > heptane > toluene and *m*-xylene > *o*-xylene > *p*-xylene. As seen from this, the formation of complexes with thiourea has complications which are more extensive than is the case with urea complexes.

In a general sense, the physical properties of thiourea complexes are similar to those of urea complexes. The crystal structure differs somewhat from urea complexes in that the arrangement of thiourea molecules is rhombohedral and the diameter of the lumen is greater. Densities of thiourea complexes calculated from crystallographic data agree with those obtained experimentally. Molal and weight ratios are lower than those for urea complexes because of the structural differences.

As a result of these structural differences, the energy values involved in the formation of thiourea complexes are lower than for urea complexes. Redlich et al.[16] have obtained equilibrium constants for the decomposition of a number of thiourea complexes consistant with Equations (2) and (3). Some of these values are presented in Figure 10 as a function of temperature. A comparison of Figure 10 with Figure 3 shows that the equilibrium constants for thiourea complexes are generally higher. This reflects the generally low stability of these complexes.

Further examination of Figure 10 shows the relatively low temperature coefficient of the equilibrium constants. Because of this, practical limitations prevent significant gains in stability by resorting to operation at lower temperatures. As seen from Equation (9), the low temperature coefficient of K is reflected in the relatively low values for heats of formation shown in Table 4 (data from Angla[1] and Redlich et al.[16]) It is interesting to note that the value of the heat of formation for the dimethylbutane complex is greater than that for trimethylbutane, and both of these are greater than that for the trimethylpentane; this is in spite of the higher molecular weight and greater length of the trimethylpentane. Value for cyclohexane is much greater than for the substituted isopropylcyclohexane.

TABLE 6
Heats of Thiourea Complex Formation

Reactant	$-\Delta H$ kcal./g-mole
Carbon tetrachloride	3.3
Hexachloroethane	3.1
2,2-Dimethylbutane	4.4
2,2,3-Trimethylbutane	3.7
2,2,4-Trimethylpentane	3.4
Cyclopentane	2.2
Cyclohexane	3.6
Cyclohexane	3.1
Cyclohexenone	3.6
Isopropylcyclohexane	1.5

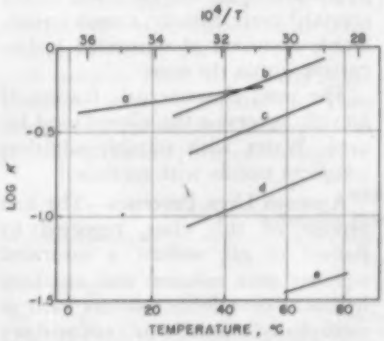
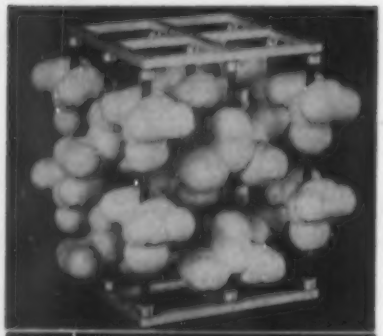


Figure 10. Equilibrium constants for thiourea complexes: (a) isopropylcyclohexane, (b) 2,2,4-trimethylpentane, (c) cyclopentane, (d) 2,2,3-trimethylbutane (triptane), (e) cyclohexane.

Some of the anomalies in the formation of thiourea complexes can be explained on the basis of deformation of the reactant molecules within the lumen. This formation results from a non-homogeneous distribution of forces in the thiourea complex, and it can account for the fact that often several successively longer isomers all have the same molal ratio.

Because of the wide variety of reactants and the anomalies observed for thiourea complexes, relationships for free energy, molal ratio and heat of formation cannot be expected to have the general application that can be achieved with urea complexes. However, it is possible to obtain helpful correlations in some cases by classifying reactant types and correlating them on the basis of reactant length. There will be significant deviations, but such correlations can be useful if their limitations are recognized. The low stability of some of the thiourea complexes results in rapid dissociation when the crystalline adducts are exposed to the atmosphere. Further complications occur in washing the complexes after they have been filtered. Many convenient solvents often cause appreciable dissociation of the adducts, but this can be overcome in some cases by using as the wash solvent some material which is itself an adduct-former.

Original presentation was at the American Chemical Society, March 28-April 7, 1955, Cincinnati. ##



Urea Complexes

How They're Applied

Practical urea processes have already been devised to remove selectively the straight-chain hydrocarbons from fractions ranging from gasoline to heavy distillates.

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EXTRACTIVE crystallization with urea or thiourea, which separates according to the shape of the hydrocarbon molecule, is one of the newest potentially useful petroleum segregation techniques. The urea process provides a practical means for selectively removing the straight-chain hydrocarbon components from fractions ranging from gasoline to heavy distillates. This article will review the more important applications such as the production of pure n-paraffins, alpha-olefins from cracked stocks, low pour-point diesel and jet fuels, lubricating oil bases, straight chain and specialty waxes, gasoline of improved octane number, diesel oil of higher quality, and others. A single urea process unit could be sufficiently flexible to be used in all of the above applications.

Although several cyclic processes utilizing the reversible urea inclusion complex have been available for several years, none has yet been applied on a commercial scale. Factors which have restricted this growth will be discussed. The issue of approximately 80 patents to 7 major petroleum companies covering all phases of the problem is evidence of their continued interest in urea treating. The use of complexes as a petroleum laboratory separation and analytical tool is now well established.

Processes—Each of the various cyclic continuous processes which have been proposed involves four steps of varying complexity: (1) formation of the crystalline adduct by agitation of the hydrocarbon with either dissolved or solid urea, (2) separation of the reaction product into crystalline adduct and liquid phases, (3) decomposition of the adduct into the urea solution and hydrocarbon, and (4) purification of the product streams and recovery of urea and solvents. The principal difficulty inherent in all urea processes results from the voluminous character of the adducts or inclusion complexes which crystallize into small hexagonal needles giving a very porous mass of low bulk density. The pure complex, containing approximately 24 percent hydrocarbon, has a density of around 1.20 (1.33 for the tetragonal solid urea). This low bulk density, together with an apparent tendency of the hydrocarbon to wet the ends of the crystals[8] preferentially, causes considerable occlusion of unreacted hydrocarbon within the mass.

The most characteristic feature of a cyclic process is the solvent used for urea. Water with suitable additives competes mainly with methanol.

Aqueous Urea Processes—The first process of this class, reported by Bailey[6] et al., utilizes a saturated aqueous urea solution and auxiliary hydrocarbon-soluble solvents such as methylethylketone[6,7] or secondary butyl alcohol[9] for gasoline fractions and methylisobutylketone for heavier distillates. This has been operated on a two barrels per day continuous pilot plant scale. In general, an aqueous process has the advantage that very little solubilization of urea in the hydrocarbon phase occurs. This minimizes the problem of urea recovery. The urea solution serves alternately to convey, wash, and decompose the complex. The semi-polar solvent facilitates the rate of complex formation by increasing the rate of transfer of the n-paraffins between phases[9] and provides a suitable wash of the complex during filtration. Maintenance of a solution pH below 7 by additions of acetic acid improves the crystallization rate and the size of the crystals.[10] Example conditions for a Diesel oil fraction (12 percent n-paraffin) are as follows:

Aqueous urea/oil (volume)	3.2
Solvent/oil (volume)	1.5
Inlet reactor temperature, °F	90
Outlet reactor temperature, °F	40 to 80
Contact Time, minutes	15
Pressure	Atmospheric

Garner[11] et al. and Busso[12] have simplified the process by the use of special detergents and electrolytes in the aqueous urea solution. These additives allow rapid wetting of the entire crystal surface by the aqueous phase so that separation by simple settling into the urea solution (1.10 to 1.14 density) is possible. This approach avoids the use of auxiliary solvents. As examples, they report treating cracked wax olefins or a wide range of petroleum fractions (1 vol-

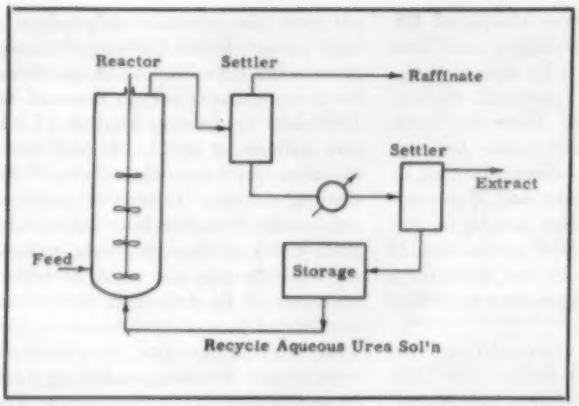

Figure 1. Detergent-aqueous urea process: It's been successfully tested in a pilot plant.

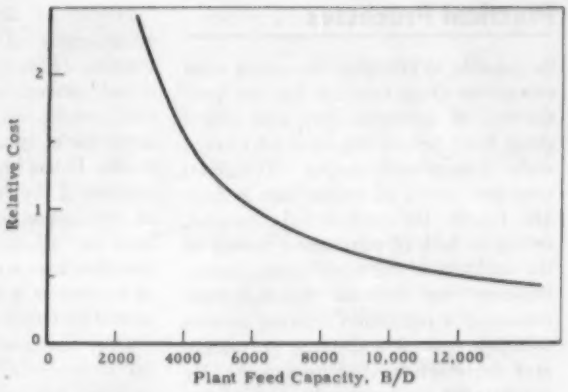

Figure 2. Process costs versus plant size for n-paraffin extracts.

ume) with a saturated aqueous urea solution (3-5 volumes) containing 10-20 weight percent low boiling alcohol, 0.15 weight percent or higher concentration of sodium C_{10} alkylsulfate, and 4 weight percent potassium chromate. The chromate serves to inhibit corrosion[14] and to improve the reaction. This procedure is particularly effective for removing components of low reactivity from the hydrocarbons where dilution is unfavorable. The process also has been successfully tested on a pilot scale (Figure 1). Arnold[13] and co-workers describe dewaxing with an aqueous solution free of additives.

Alcohol-Urea Processes—The use of a saturated methanol-urea solution was first suggested by Bengen[1] and investigated by Zimmerschied[4] et al., Schlenk[5], Redlich[6] et al., Arnold[15], Adams[18] and others.[69] Reaction rate barriers and inhibition by sulfur compounds[16] and high molecular weight substances[4, 6] can often be reduced or avoided by the use of this technique. A process utilizing alcohol solutions can be operated at lower temperatures than one based upon aqueous solution but recovery of solvent and urea is more complicated. This procedure is particularly useful in laboratory preparations and for treating waxes and heavy distillates.

The problem of chemical recovery can be partially reduced by the addition of water[4, 20] to the methanol solution or almost completely avoided by going to a solid urea process promoted with minor amounts of solvent. A number of investigators have considered this approach.[17, 19, 21, 22, 26, 27, 28, 29]

Other solvents such as NH_3,[30] SO_2,[31] amines,[25] chlorocarbons,[32] cresols,[33] nitriles[34] have been explored. Centrifuging[35] and azeotropic distillation[36] have been reported.

Applications—

Pure n-Paraffins and Olefins—Urea extractive crystallization processes are capable of producing enormous amounts of n-paraffins from C_7 to C_{24} and even as high as C_{50} depending upon the starting material. The paraffin can be obtained free from branched or cyclic compounds and the usual S, O and N contaminants found in crude oils. Purities above 99 percent have been obtained (Table 1). Separations from stocks high in n-paraffins and sulfur compounds such as those found in West Texas may be of particular interest. Crude oil supply contains up to 30 percent n-paraffin in some areas. If it may be assumed that most kerosine and gas oil fractions range above 10 weight percent n-paraffin content, a potential of over a billion pounds per year in the U. S. A. alone is estimated. No other single class of compounds existing in petroleum has the same degree of similarity in structure and chemical properties. Fractional distillation of the mixed n-paraffins yields substantially pure individual compounds.[6, 8, 37, 38]

At present there is no large scale demand for pure n-paraffins. They have been considered as feed-stocks for the preparation of detergents, chloroparaffins, fatty acids, and as aluminum rolling mill lubricants. These and other small scale applications, however, can now be supplied from selected crudes without resorting to urea treating. Kerosine range n-paraffins are nearly odorless[6] and have excellent penetrating qualities useful as an odorless dry cleaning solvent, paint thinner, and selective solvent for vegetable oil extraction. n-Paraffins would have to compete in these applications with alkylate solvents (15-17 cents per gallon) now available. The cost of the n-paraffin extract would depend on the scale of manufacture (Figure 2), purity, and process conditions, but may be qualitatively estimated as similar to a wax refined by conventional methods. Additional credits from an up-graded raffinate (unreactive hydrocarbons) would give added incentive.

When mixed waxes are thermally cracked, they provide high yields of straight-chain olefins with the double-bond predominantly in the alpha position. Garner[11] and co-workers describe the separation of these products from the branched chain components with urea. Thermally cracked gasoline and gas oils[6] also contain as high as 30 percent straight-chain olefin in the urea extract fraction. Gorin[39] also describes urea-alpha-olefin reactions.

In other areas of the world it may

TABLE 1
n-Paraffin Product Properties

SP. Gr. 20/4° C.	C_{12}-C_{20+} 0.774	C_{12}-C_{16} 0.760	C_{15}-C_{17} 0.773	C_{18}-C_{20+} 0.778 at 35/4° C.
Color	Water-white	w-w	w-w	w-w
Melt. Range, °F.	40-55	15-25	45-55	89-90
Bromine No.	0.1	0.1	0.2	0.1
Dist. IBP, °F.	460	428	496	576
FBP	557	491	553	592
n-Paraffin, % vol.	95+	98+	95+	95+

be feasible to consider the use of urea extractive crystallization for the production of synthetic fats and detergents from petroleum on a very large scale. The present output (20 million tons per year) of edible fats is only one-fourth the potential demand, owing to lack of purchasing power of the majority of the world's population. Seaman[40] has made an economic evaluation of a combined refining process utilizing several existing petroleum and petrochemical processes. He shows, contrary to popular belief, that synthetic fat production is a practical possibility. Important features of the process include (1) a crude wax cracking unit, (2) a urea-complex plant for the separation of n-paraffins and olefins from cracked waxes and their n-fatty acid oxidation products, (3) means for the separation of the odd and even number C-atom products (to avoid metabolism problems), and (4) a synthetic glycerine plant.

Gasoline Treating—n-Paraffins contained in gasoline and naphtha have the lowest octane rating, averaging —20 (ASTM) or lower. Their removal from a Los Angeles basin naphtha[6] raised the octane number by 11 to 12 units. Shortly after World War II when the average gasoline blended octane level was approximately 80, urea treating was briefly investigated as a means for improving this rating. With premium gasoline now having a blended octane number in the range of 90-95, urea extractive crystallization cannot compete with catalytic reforming as a method for octane improvement. In addition, the n-paraffins in the gasoline range are the least reactive and require special operating conditions to provide even partial extraction.

Jet Fuel—Urea treatment provides one of the most effective means for refining kerosine to produce specification grade military jet aviation fuels.[41, 42] The most exacting specification of the JP-3 (high vapor pressure) and JP-4 (low vapor pressure) grades is that the freezing point should be below —76 F. This sharply limits the available kerosine stocks which can be used for this purpose. Since the freezing point of the kerosine fraction is determined almost entirely by the proportion of straight-chain molecules present, their removal can provide reductions of over 100 F. in the pour point.

Hepp[41] et al. have compared the effectiveness of distillation and urea treating (Figure 3). In time of a national emergency fractional distillation would exclude from use large amounts of otherwise usable kerosine stocks. It has been estimated[43] that 75 percent of the kerosine and 50 percent of the motor gasoline would be utilized in "all out" JP-4 production. If specifications are to be met, some form of treatment to remove the n-paraffins would be required.

Cost limitations are most restrictive on commercial jet fuels; very little increase through refining can be tolerated. If it were not for the difference in price between aviation gasoline (17 cents per gallon, December, 1953) and jet grade kerosine (10.8 cents per gallon), profitable airline operations of turbine aircraft would be impossible.[44] Adequate stocks appear to be available for future commercial aviation even though there is a trend towards the lower volatile kerosines. Commercial jet fuel consumption in the U. S. is predicted to be only one million barrels by 1957 or 0.04 percent of our total crude.

Diesel Fuel—Diesel Fuels have commanded very little premium for higher cetane content. Up to the present time the incentive to produce a high cetane Diesel fuel by the urea process has been lacking. A predicted 35 percent increase in demand by 1960 over the present total of 6.7 billion gallons in the U. S. will focus attention on various additives[45] including cetane improvers such as amylnitrate.[58] n-Paraffins extracted from heavy gasoline, jet fuels, and gas oil fractions can also serve as cetane improvers.[42] By definition, the cetane number of pure n-hexadecane is 100. The other n-paraffins likewise have high cetane numbers, including those from the naphtha boiling range. The addition of 11 percent urea extract (97 cetane no.) to a 40 cetane light Los Angeles basin stove oil[6] would raise the value of the mixture to 45, the average value for railroad fuel. The author[42] has developed a special arctic diesel fuel by combining a stove-oil or diesel urea raffinate with a jet fuel range extract. For these and other reasons, efficient transfer of n-paraffins from one hydrocarbon fraction to another by means of urea may some day become feasible.

In other respects the diesel fuel problems are very similar to those mentioned for jet fuels: (1) About 65 percent of the cost of operating a locomotive is for fuel, so that little increase in the fuel value (10-11 cents per gallon) can be tolerated. (2) The availability of specification-grade military diesel fuel, which now only amounts to 6 percent of the total, may be very critical in case of an "all-out" situation.

Dewaxing—During the early stages of investigation of urea extractive crystallization, the possibility of dewaxing lubricating oil stocks without refrigeration, in addition to the other applications previously discussed, appeared to be a very attractive objective. Research[3, 4, 5, 6, 39, 46, 49] soon demonstrated, however, that sorting molecules according to shape does not correlate exactly with conventional solvent dewaxing results based upon freezing points. The melting point of a long chain branched or cyclic paraffin often correlates well with that of the n-paraffin equal in length to the longest unbranched chain in the molecule.[47, 48] (Figure 4.) On the other hand, many branched and cyclic waxes of high melting point may have average cross sections too large for inclusion in the urea complex. This would not permit, therefore, the complete dewaxing of certain crude stocks.

Meet the Author

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According to correlations by Gorin,[39] a methyl side-group (2.31A) on a paraffin requires a minimum of 10-13 straight-chain C-atoms before complexing will occur, whereas an ethyl branching (3.19A) requires over 24 C-atoms. Only considerably longer paraffins with short branches are efficiently removed from a mixture such as a wax or lubricating oil distillate.

Arabian and Schaerer[50] have utilized these differences in reactivity to separate from conventional microcrystalline wax a predominantly straight-chain portion (650-750 M.W.) having unusual properties similar to carnauba wax. This fraction for instance, is capable of retaining hardness when mixed with lower boiling diluents. Rumberger[51] describes the advantages of the urea-unreactive portions of microcrystalline waxes when applied to paper coatings. Fischer-Tropsch[40] and shale oil[54] components have also been treated. In view of these findings, urea extractive crystallization may be considered to be a complementary process to conventional dewaxing for the purpose of producing specialty wax fractions.

Urea treating is effective in some areas for dehazing[46, 52] potential lubricating oils low (0—3 per cent) in n-paraffin wax content. In this case the removal of the paraffin can be practically quantitative. If accomplished without a diluent, this approach could have advantages over conventional treating, particularly for producing refrigeration equipment lubricating oils.[53] Considerable study on waxes by Arnold[55] and co-workers is indicated by the patent literature.

Thiourea Complexes—The author[56] in 1946, while attempting to improve the complexing reactivity of the lower boiling n-paraffins, tested mixtures of n-heptane in isooctane, cyclohexane, and CCl_4 with saturated thiourea solutions and discovered that the non n-paraffin components were reactive. Angla[57] independently reported the "reaction" with naphthenes, cyclic terpenes and chlorocarbons and later[58] the isoparaffins.

Although there have yet been no commercial applications of thiourea, an interesting combination extraction and oxidation process involving cyclohexane has been suggested by Ackerman.[62] While a thiourea process can effect a separation of certain highly branched components from aviation alkylate, there has been no economic incentive to do so. The use of thiourea

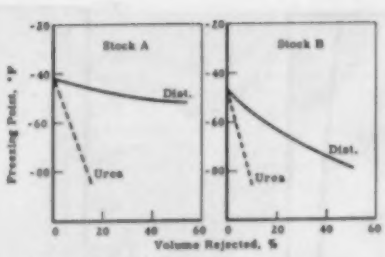

Figure 3. Production of JP-4 Jet fuels: Urea process rejects much less than distillation.

complexing as a laboratory tool and for separating premium chemicals from mixtures appears to be the most promising application at present.

In the case of thiourea it is more difficult to determine by inspection whether a particular molecule is capable of complex formation. The potential inclusion molecule must have a cross-sectional diameter lying between 5.9 and 7.6A; a single methyl group in a straight-chain is not usually sufficient to confer complexing properties on the molecule under normal conditions. The squalene-thiourea complex[63] represents one of the more recent derivatives reported. Of theoretical interest is the observation[64, 65] that cetane will form rather unstable complexes with thiourea, contrary to earlier beliefs.

Original presentation was at the American Chemical Society, March 28-April 7, 1955, Cincinnati.

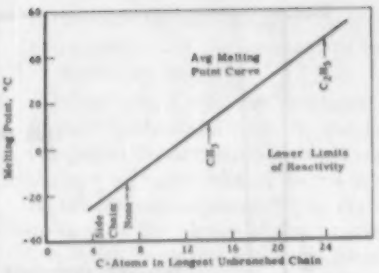

Figure 4. Wax melting point versus urea complex stability.

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End of Symposium

Urea Complexes

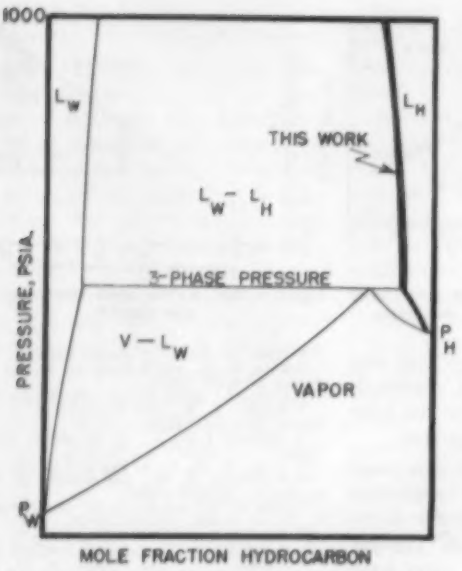

Figure 1. Schematic pressure-composition diagram indicates the region of this investigation

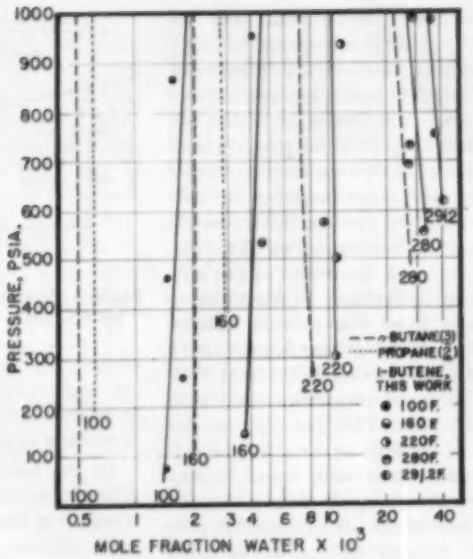

Figure 2. How the solubility of water in light hydrocarbons compares

The Solubility of Water in 1-Butene

Water is as much as three times more soluble in 1-butene than in saturated paraffin such as n-butane and propane.

W. B. Brooks and John J. McKetta,
Texas Petroleum Research Committee and Department of Chemical Engineering, University of Texas, Austin

THE SOLUBILITY of water in 1-butene was determined experimentally at pressures to 1000 psia and temperatures up to the critical temperatures of 1-butene, 291 F. In an earlier paper[1] the solubility of 1-butene in water was presented. The purpose of this study was to compare these data with the solubility of water in propane[2] and in *n*-butane.[3]

Figure 1 is a schematic diagram of the general hydrocarbon-water systems. The equilibrium hydrocarbon-rich liquid phase studied in this investigation is shown by the heavy solid line.

The experimental data are presented in Table 1. These data are plotted as isotherms on a pressure-composition diagram in Figure 2. Also in Figure 2 are shown the similar data for the propane-water system[2] and the *n*-butane-water system.[3] Since the three-phase critical temperature for propane is 205.7 F., the propane-rich liquid does not exist above this temperature.

TABLE 1
Experimental Values for the Composition of the Hydrocarbon-Rich Liquid Phase in the 1-Butene-Water System.

Pressure (Psia.)	Mole Fraction Water x 10^3	Pressure (Psia.)	Mole Fraction Water x 10^3
Temperature = 100 F.		Temperature = 280 F.	
63.2	1.41	561.0	32.14
261.0	1.75	686.0	26.80
464.5	1.45	726.0	27.65
867.0	1.57	986.0	29.19
Temperature = 160 F.		Temperature = 291.2 F.	
146.5	3.72	624.0	40.98
534.5	4.48	752.0	37.26
954.0	4.04	981.0	36.27
Temperature = 220 F.			
302.0	10.83		
501.0	11.16		
573.0	9.52		
931.0	11.94		

Mr. Brooks' address: Magnolia Petroleum Company, Production Research Laboratories, Dallas.

In Table 2 are shown the smoothed data for the 1-butene-water system. These values were obtained from the solid lines of Figure 2.

ACKNOWLEDGMENT
The 1-butene used in this work was furnished Phillips Petroleum Company.

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TABLE 2
Smoothed Values of the Composition of the 1-Butene-Rich Liquid Phase

Pressure (Psia.)	Mole Fraction Water x 10^3	Pressure (Psia.)	Mole Fraction Water x 10^3
Temperature = 100° F.		Temperature = 220° F.	
* 63.2	1.406	*301	10.83
80	1.41	400	10.8
100	1.41	500	10.8
200	1.46	600	10.8
300	1.51	700	10.8
400	1.55	800	10.8
500	1.60	900	10.8
600	1.65	1000	10.8
700	1.71		
800	1.76		
900	1.82	Temperature = 280° F.	
1000	1.88		
		*561	32.14
Temperature = 160° F.		600	31.5
		700	30.2
* 146.5	3.72	800	29.0
200	3.78	900	27.8
300	3.86	1000	26.7
400	3.95		
500	4.03	Temperature = 291.2° F.	
600	4.14		
700	4.24	*624	40.98
800	4.35	700	39.6
900	4.45	800	38.0
1000	4.57	900	36.4
		1000	34.9

* Three-phase Critical Pressures.

Area of Inquiry	Assigned to
1. Laws	Legal Department
2. Community	Public Relations
3. Labor	Industrial Relations Department
	Wage and Salary Department
4. Taxes and Insurance	Taxes and Insurance Departments
5. Financing	
Property and Stores	Treasury Division
Pro Forma Statement	
6. Process Evaluation	
Raw Materials	
Production Costs	Production Division
Warehousing and Shipping	
Maintenance Facilities	
7. Sites and Building	
Water	
Power	Engineering
Capital Cost	
Advisability of Moving	
8. Sales and Distribution	Sales Division
Transportation	
9. Climatic Conditions	Research and Development
Patents and Licenses	

Figure 1. Plan for styrene plant investigation.

Plant for Sale— Should You Bid?

Here is how a company made its decision on bidding for one of the styrene plants in the proposed sale of government synthetic rubber facilities.

Paul L. Weller,
Spencer Chemical Company,
Kansas City, Mo.

MANAGEMENTS of many companies were interested in bidding on the government plants in the synthetic rubber program. How did they go about translating this interest into a decision on submitting a bid? Here is the case history of the procedure used by one company in doing this. Their decision was not to bid on the specific plant under study. This, of course, points up the factors that an individual company must consider. Actually, an acceptable bid on this plant was made by another company and is now waiting for approval by the Congress, an indication that existing conditions do not bear the same weight for each company interested in bidding.

There are roughly three ways in which a corporate organization can expand:

- Development of new products or processes through research.
- Purchase of a product, process or going manufacturing operation.
- Expansion of existing facilities for current products or processes at the same or other new locations.

The case example presented is concerned with the second type of possible expansion or that through purchase of an existing product. Styrene is a product which has two current large scale uses in two major industries and the study of which gives an example of the application of marketing research in a possible avenue of corporate expansion. The study of styrene in this instance involved every function of the company as well as marketing research.

When such a study is undertaken at Spencer Chemical Company, the Development department is charged with the over-all supervision of such a project. It is their responsibility to decide in view of the nature of the problem just what company functions should be involved in the study. For this styrene study, every function was asked to participate and their fields of inquiry were outlined as follows as the first step in the program.

In addition to the outline shown above, each function was given a list, developed with their cooperation, of the major data or information desired from each organization within the company. For example, the wage and salary group made a study among many things of wage rates, cost of living, type of labor available, standard of living, labor stability, labor dispute records, unions, safety record and organization, benefit programs, and so forth. The Production division under process evaluation for example was concerned with: the description of the processing including operating conditions, hazards, raw materials required, necessary utilities, by-products, waste disposal; process control; determination of break-even point.

In this instance the entire area of inquiry for the Sales division was assigned principally to the Market Research Section. This included the following as but part of the total amount of information required:

A. Develop the demand for styrene by end use pattern.

B. Obtain, if possible, sales commitments that can later be affirmed.

C. Prepare consumption maps and estimate freight costs and equalization.

D. Estimate future prices for styrene.

E. Prepare annual net realization figures for the first five years of operations in conjunction with Accounting.

F. Determine the location and capacity of other production facilities.

G. Project a pattern for necessary sales personnel, offices, advertising and other expenses so that the annual sales expenses can be shown for the first five years' experience.

H. Obtain product specifications as required by the trade.

Bidding on Plants . . .

I. Estimate tank car, warehousing, and other shipping facilities requirements.

J. Analyze buying habits.

K. Determine market characteristics.

1. Competitive price policies
2. Competitive marketing policies
   a. Customer service
   b. Credit and invoicing terms, contracts
   c. Type and training of sales personnel
   d. Advertising policies
   e. Location of sales offices, sales personnel and warehouse locations
3. Analysis of individual markets
   a. Location of markets by end uses
   b. Factors affecting future consumption trends by end uses.

Obviously, this list is incomplete, but it does give some idea of the type of information that was developed by the Market Research section.

Where an established product is being successfully manufactured on a regular basis, the most important questions are concerned with its present and future sales prospects. To start its part in the overall study, the Market Research section first initiated an intensive literature study to determine from this source as much as possible all the information available on the various desired subjects. With this information then assembled and analyzed, the next step was to obtain directly from the field the balance which in this case included the bulk of it, of the information necessary to complete the study. Government statistics gave production data to date for styrene and the various products in which it is used. But to properly interpret them for future sales prospects for styrene, considerable background and industry information had to be developed.

Consequently, a program was initiated to make contacts in the supply and consuming markets for styrene, principally rubber and plastics. In the plastics field various industry sources were contacted in order to make estimates of the amount of polystyrene going into appliances, housewares, toys, novelties, and other lines, the amount of styrene going into paint, latices, polyesters, various copolymers, and other end uses. Factors affecting future consumption trends were also sought. The necessity of analyzing every bit of market data is shown in the fact that there was found to be a very rapidly developing trend toward the use of high-impact polystyrene particularly in the appliance and toy markets. With the use of butadiene as a copolymer or as a blend, considerable styrene is displaced to produce the high-impact polystyrene. A survey of the toy industry was made which showed a decided preference for polyethylene toys for greater durability at the expense of polystyrene. Yet the properties of high-impact styrene were found to be opening up new uses not previously available to polystyrene type plastics.

The battle between synthetic and natural rubber was also studied as well as the possible emergence of other synthetic rubbers such as butyl for large scale general use. This, of course, involved contacts with research people who could advise on some of the possible developments in the rubber industry. Paint technologists were also contacted to forecast the future of styrene latices in competition, for example, against new developments in acetate latices. Out of all this information consumption forecasts were built up on the various styrene end uses.

From a marketing research standpoint, a good general overall viewpoint on the total styrene markets was then obtained. The next step was then to consider just how this individual plant fit into the market and where its production could be sold. This particular plant is located in the Los Angeles area and represents about 10 to 12 percent of the national styrene capacity which is currently being utilized at a rate of some 60 percent.

Briefly, the only plastic market of significance on the West Coast for styrene is in the two existing polystyrene plants there which are operated by large competitive producers of styrene in the Texas area. This then meant that the plant would have to place a large share of its output in the production of GRS rubber in the adjacent synthetic plant, shipping the balance into eastern markets. Further investigation showed that even at maximum production, the West Coast GRS plant could consume only 37 percent of the West Coast styrene capacity. Also the general study had shown a national oversupply of GRS that probably wouldn't be fully utilized until 1958 or 1959 and also an oversupply of styrene for a somewhat lesser period. With production costs depending so much on the price paid for the plant, it was doubtful that, with the amount of freight equalization that would have to be absorbed, a large market could be developed to operate this styrene plant at economical levels for the next four to five years. Further no basis could be found to feel that the West Coast GRS plant would itself be operated until West Coast rubber demand increased sharply or the excess GRS capacity nationally is fully utilized.

Consequently, as a final phase of this study, the Market Research section made an even more detailed study of the entire rubber industry on which the operation of this West Coast styrene plant depends so heavily. Efforts were made to try to forecast the probable disposal pattern for the acquisition of the synthetic rubber facilities by private industry. It was felt that some possible patterns would result in varying levels of operation of the West Coast plant.

Market Research representatives rechecked the market again just before the bidding deadline to ascertain the possibility of disposal patterns more favorable to the operation of this styrene plant becoming a reality. When it became apparent that none of the desired patterns would have a chance of succeeding, the study was dropped. As a consequence, no bid was submitted because of marketing problems which this plant, by itself, poses for some types of operators.

Original presentation was before the American Institute of Chemical Engineers, Tulsa, October, 1954.

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About the Author

PAUL L. WELLER, market research manager for Spencer Chemical Company in Kansas City, Mo., was graduated from Ohio State University in 1935 and in 1938, received a M.B.A. degree there. Before joining the Spencer organization, Weller was employed as a senior development engineer with Goodyear Tire & Rubber Company and later, as a district sales manager for Wyandotte Chemicals Corporation. He is a member of the New York City Chemists Club and Chemical Market Research Association.

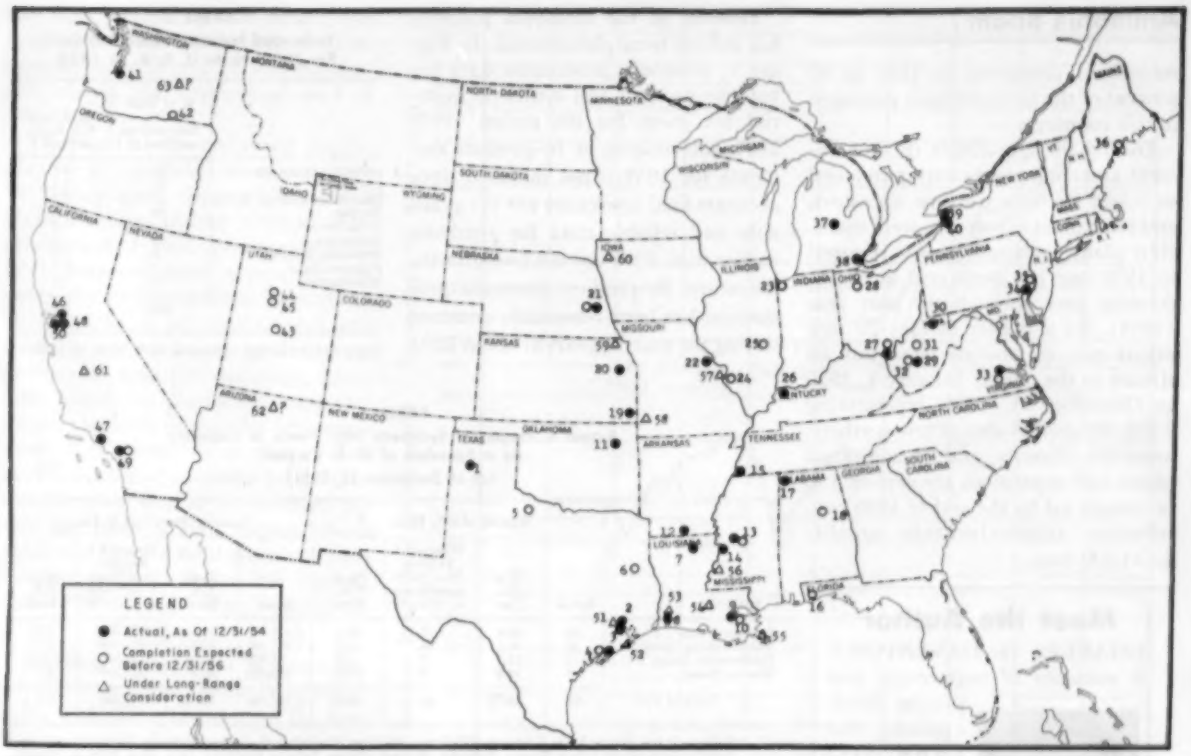


Figure 2. Distribution of actual and proposed synthetic ammonia plants in the United States.

Boom Still on for U. S. Ammonia

Capacity has more than doubled in last ten years. Investment in facilities during 1950-54 period was over $212 million. Another $265 million will be spent before 1957.

C. H. Davenport,
Lion Oil Company,
El Dorado, Arkansas

THE TREMENDOUS increase in synthetic ammonia capacity is making it one of the top petrochemicals from the standpoint of both production and money invested in facilities. Existing plants have a capacity exceeding 3.3 million short tons per year. Proposed plants would boost this total by more than 1.4 million making a total by 1957 of about 4.8 million short tons per year capacity.

In spite of some feeling that capacity will exceed demand, new plants continue to be proposed. What have been the primary factors in this growth? How has the development taken place? Here are some of the highlights and pertinent facts to answer these questions.

Growth of the Industry—Production of synthetic ammonia in the U. S. received a rather slow start. In 1921, there was only one plant in the U. S. It produced a total of only about 3600 tons annually. By 1932, there were 10 synthetic ammonia plants in operation with a combined capacity of 385,000 tons annually. This meant that the production of synthetic ammonia amounted to about four times that of by-product ammonia, this being sufficient for domestic requirements until 1940.

High demands for munitions provided the stimulus for an extensive expansion in synthetic ammonia capacity beginning in 1940. As a result, 10 new ammonia plants were constructed during 1940-43. Their combined capacity was approximately 800,000 short tons of synthetic ammonia annually. Actual production from these plants plus that from privately operated plants just

Ammonia Boom . . .

mentioned amounted in 1943 to 83 percent of the fixed nitrogen produced in this country.

During the late 1940's the government ammonia plants were purchased or leased by their wartime operators, and some plant expansions were made. New plant construction was resumed in 1950 and has continued at an increasing pace through the past year (1954). As a matter of fact 20 new plants and expansions were put on stream in the period January 1, 1950 to December 31, 1954, representing 1,258,000 annual tons of new synthetic ammonia capacity, and 23 additional plants and expansions are expected to be completed by the end of 1956 contributing approximately another 1,423,000 tons.

Meet the Author

CHARLES H. DAVENPORT is manager of engineering and process development for Lion Oil Company's Research division at El Dorado, Ark. Holder of a Sc. D. degree from M. I. T., Dr. Davenport joined Lion with a broad background in practical as well as theoretical chemistry and engineering. Beginning his work in the chemical industry during his summers as a student from the University of British Columbia, Dr. Davenport later joined Standard Oil Development Company. After serving Standard two years as a research chemical engineer, he became chief engineer in chemical research and development for Swift & Company's Plant food division. During World War II, he was active in the development of high- and low-temperature greases and in-industrial lubricants, and conducted research in the recovery of strategic metals from low-grade ores. A member of AIChE and ACS, he holds several patents in chemical technology and is author of a number of technical articles.

Davenport

Growth of the ammonia industry has indeed been phenomenal. In Figure 1, ammonia production data for both by-product and synthetic material are given for the period 1919-1954. Information on by-product ammonia for 1954 is not included since accurate final figures are not yet available and reliable data for synthetic earlier than 1939 are not found in the literature. By-product ammonia production has been reasonably constant during the past 13 years at about 220,-

TABLE 2
Estimated Industrial Distribution For Fixed N_2 In U. S. A. In 1953

	% of Total Indust. Consumption of Fixed N	% of Total U.S. Prodn. of Fixed N
Industrial Explosives	26	5.2
Chemicals	26	5.2
Plastics & Synthetic Resins	11	2.2
Textiles	10	2.0
Metal Treating	6	1.2
Refrigeration	5	1.0
Petroleum Refining	3	0.6
Pulp and Paper	3	0.6
Miscellaneous	10	2.0
	100%	20%

Source of Information: Chemical Week (12/19/53, p. 70)

TABLE 1
Actual & Proposed Synthetic NH_3 Plants & Capacity, As a Function of U. S. Region
(as of December 31, 1954)

REGION*	Number of NH_3 Plants				Capacity (Short Tons N/Year)			
	Actual	% of U.S. Total	Proposed & Building (New Plants or Additions by 12/31/56)	% of U.S. Total	Actual	% of U.S. Total	Proposed & Building (New Plants & Additions by 12/31/56)	% of U.S. Total
Southern States	13	39.4	7	30.4	1,110,500	40.5	350,500	29.9
Mid-Continent States	10	30.3	10	43.5	1,294,500	47.2	539,000	45.9
Northeastern States	4	12.1	1	4.3	54,000	2.0	37,500	3.2
Western States	6	18.2	5	21.8	282,000	10.3	247,500	21.1
Total for U.S.	33	100%	23	100%	2,741,000	100%	1,174,500	100%

* Southern States include Texas, Louisiana, Oklahoma, Arkansas, Mississippi, Tennessee, Alabama, Florida.
Mid-Continent States include Kansas, Nebraska, Missouri, Illinois, Indiana, Kentucky, Ohio, West Virginia, Virginia, Pennsylvania.
Northeastern States include Maine, Michigan, New York.
Western States include Washington, Utah, California.

TABLE 3
Production of By-Product & Synthetic Ammonia In U. S. A. During 1919-1954
(thousands of short tons as NH_3)

YEAR	By-Product Production From Coke Ovens			Synthetic Production			Total From All Sources
	As Ammonium Sulfate	As Ammonia Liquid	Total By-Product	In Commercial Plants	In Government Plants	Total Synthetic	
1919	68.0	25.3	93.3	....	....	....	....
1920	84.5	32.9	117.4	....	....	....	....
1921	66.1	15.9	82.0	....	....	....	....
1922	86.9	25.0	111.9	....	....	....	....
1923	114.5	29.3	143.8	....	....	....	....
1924	111.6	24.5	136.1	....	....	....	....
1925	127.1	32.6	159.7	....	....	....	....
1926	146.0	26.8	172.8	....	....	....	....
1927	152.0	27.3	179.3	....	....	....	....
1928	173.5	26.2	199.7	....	....	....	....
1929	186.0	28.0	214.0	....	....	....	....
1930	167.7	24.5	192.2	....	....	....	....
1931	123.0	19.5	142.5	....	....	....	....
1932	71.9	16.6	88.5	....	....	....	....
1933	84.8	20.3	105.1	....	....	....	....
1934	98.2	21.8	120.0	....	....	....	....
1935	115.4	20.9	136.3	....	....	....	....
1936	150.0	23.6	173.6	....	....	....	....
1937	161.2	27.1	188.3	....	....	....	....
1938	109.2	20.4	129.6	....	....	....	....
1939	145.1	24.1	169.2	311	0	311	480
1940	179.6	28.5	208.1	465	0	465	673
1941	186.3	31.4	217.7	501	0	501	719
1942	191.7	33.9	225.6	543	160	703	929
1943	190.3	34.1	224.4	543	534	1077	1301
1944	204.6	31.7	236.3	844	702	1246	1482
1945	191.1	27.6	218.7	549	551	1100	1319
1946	160.9	25.0	185.9	726	260	986	1172
1947	202.4	25.7	228.1	1114	330	1444	1672
1948	207.7	24.8	232.5	1090	285	1375	1607
1949	189.2	22.7	211.9	1294	250	1544	1756
1950	207.8	23.4	231.2	1566	....	1566	1797
1951	224.6	24.9	249.5	1767	....	1767	2017
1952	200.6	22.1	222.7	2053	....	2053	2276
1953	....	....	261	2288	....	2288	2549
1954	....	....	....	2691	....	2691	....

Notes: (1) Source of Information: Stanford Research Institute, Chemical Economics Handbook, p. 703.31.
(2) TVA production of synthetic ammonia is included in "Commercial Plants" rather than "Government Plants", which has been Census Bureau practice.
(3) January-October, 1954, production of synthetic NH_3 taken from Chemical Market Abstracts (Foster D. Snell, Inc.). November and December productions were not available but were estimated from a comparison with November-December data for 1953.

000 tons annually. This figure was reached previously in 1929, but production suffered and varied considerably during the depression years of 1930-40.

The marked upward swing in production of synthetic ammonia from 1939 on is quite apparent, barring a slight recession during 1944-46. The production of 3600 tons annually in 1921 does not even appear on the chart; the 1932 production capacity of 385,000 tons as previously noted was probably not equivalent to the actual production and presumably, also, some slump in production occurred for the synthetic during the depression years. It is interesting to observe that in 1952 synthetic ammonia production was 10 times that of by-product; today the ratio is even higher. As a result the line for total ammonia production in this country has hugged that for synthetic very closely since 1939.

Regional Distribution — Now consider how synthetic ammonia capacity, along with that scheduled for the next few years, is distributed across the country. Figure 2 shows the location of synthetic ammonia plants in actual production as of December 31, 1954, similar plants scheduled to be on stream prior to December 31, 1956, and plants currently under longer range consideration. This map indicates four major areas within which the production facilities appear to be grouped and these may be described as:

- *Southern States* — including Texas, Louisiana, Oklahoma, Arkansas, Mississippi, Tennessee, Alabama and Florida.
- *Mid-Continent States*—including Kansas, Nebraska, Missouri, Illinois, Indiana, Kentucky, Ohio, West Virginia, Virginia and Pennsylvania.
- *Northeastern States* — including Maine, Michigan and New York.
- *Western States*—including Washington, Utah, California and Arizona.

Current and scheduled synthetic ammonia production through 1956 will occur in 24 of these 25 states, Arizona entering the long-range picture. Noteworthy is the lack of production in the heavy fertilizer-consuming areas of the southeast; however, as will be evident later, an abundance of cheap raw material, particularly of hydrogen or stock from which it may be readily made, is one of the largest single items in determining ammonia plant location. The Southeast is not unusually endowed in this regard at the present time.

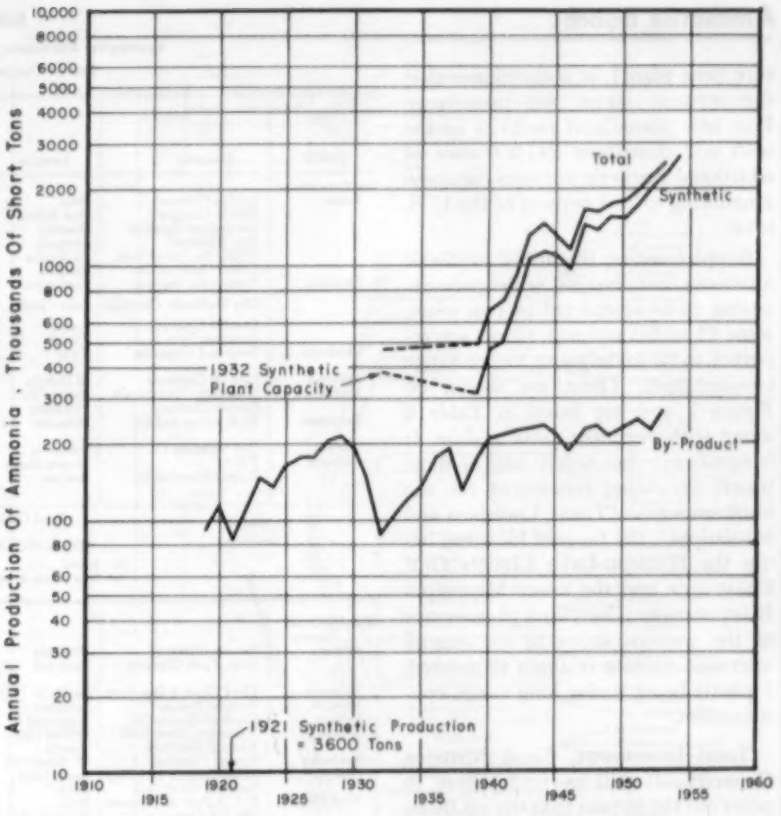


Figure 1. Production of ammonia in the United States during 1919-1954.

Now let us examine production capacities for the four regions mentioned. Since a study of individual plant characteristics is beyond the scope of the present review (however, see Table 4, on next page), consider the condensed data in Table 1. In this chart, synthetic ammonia facilities, both actual and proposed or building as of December 31, 1954, are totalled according to physical number and to design capacity. As of December 31 it is interesting to observe that there existed in the U. S. 33 plants producing synthetic ammonia with a total capacity of 2,741,000 short tons of fixed nitrogen. While the southern and mid-continent states possessed 13 and 10 plants, respectively, which accounted for 69.7 percent of the total, annual capacity for the mid-continent region was higher, being 47.2 per cent of the total versus 40.5 percent for the southern states. This fact reflects the huge capacities of the E. I. duPont de Nemour & Company, Allied Chemical & Dye Corporation, Olin Mathieson Chemical Corporation, and Spencer Chemical Company plants at Belle, Hopewell, South Point, Morgantown and Pittsburg, Kan. The relatively small size of the synthetic ammonia plants in the northeastern and western states—4 and 6 plants, respectively—is reflected in the fact that their capacities amounted to only 2.0 percent and 10.3 percent of the total for the country.

Proposed synthetic ammonia installations, including new plants and/or additions, now underway and/or contemplated for completion by the end of 1956, illustrate the tremendous current growth rate of the industry. In this group 23 installations were in various stages of completion or contemplation as of December 31. Again, it is noteworthy that 73.9 percent of these are in the southern and mid-continent states, representing respectively 30.4 percent and 43.5 percent of the total plants being built. More important, the two regions will share the new production capacity in much the same proportion (29.9 percent and 45.9 percent, respectively), accounting for 75.8 percent of the total for the country as a whole. While the northeast barely enters this expansion pic-

ture (one plant), it is significant that the western states are prominent. Five new plants and facilities in the west will contribute 247,500 tons of additional synthetic nitrogen capacity, amounting to 21.1 percent of the U. S. total.

Supplementing the above synthetic ammonia installations, which are expected to be completed in two years, some 13 additional such plants are reported to be undergoing longer range consideration. These are shown on Figure 2 and are listed in Table 6 along with pertinent facts to date. It is significant that nearly half of these plants are being considered for the southern region (Texas, Louisiana and Mississippi), the favored locations being the Houston-Lake Charles Gulf Coast area and the lower Mississippi River section. The rising prominence of the western states in the overall ammonia picture is again illustrated, 3 plants being under long range consideration.

Total Investment, Fixed Nitrogen Capacity—It will be fitting here to point out the impact that the synthetic ammonia plant expansion movement is having on our economy. Since most plants being built are of the multi-product type, that is, designed for production of synthetic ammonia plus one or more of its derivatives such as ammonium sulfate, ammonium nitrate or urea, published investment figures apply in nearly all cases to the complete installations. Consequently, one must bear in mind that published costs cover synthetic nitrogen investment as referred to several end products containing fixed nitrogen.

From January 1, 1950 until December 31, 1954, the total new investment in completed synthetic ammonia plants in the U. S. was approximately $258,600,000 (Table 5). Of this total $155,300,000 or 60 percent went into installations in the southern states. For the period from December 31, 1954, to the end of 1956 the 23 plants or expansions now building or proposed for construction will involve a total expenditure of about $270,655,000; of this $119,300,000 or 44 percent will constitute southern state ventures. At the same time investments in new plants and expansions in the mid-continent states will remain at about 30

TABLE 4

Synthetic Ammonia Capacity by Regions
(as of December 31, 1954)

STATE	Company	Location	Map Code (Fig. 2)	[1]Process	[2]Source of H_2	Capacity (Short Tons N/Year) Actual	Proposed
Southern States:							
Texas	Phillips Chemical	Etter	1	NEC	NG	126,000	.....
	Phillips Chemical	Port Adams	2	NEC	NG	128,000	.....
	San Jacinto Chemical	Houston	3	AL-H	NG	36,000	.....
	Dow Chemical	Freeport	4	ANC	BPC	31,000	30,000
	Chillicothe Petro-Chem.	Chillicothe	5	Casale	NG	.....	56,500
	United Chemical Co.	Timpson	6	?	NG	.....	47,500
Louisiana	Commercial Solvents	Sterlington	7	Kellogg	NG	110,000	.....
	Olin Mathieson Chemical	Lake Charles	8	(Kellogg / NEC)	(NG / BPC)	94,000	.....
	Lion Oil Company	Luling	9	NEC	NG	90,000	.....
	American Cyan.	Fortier	10	NEC	NG	.....	90,000
Oklahoma	Deere and Company	Pryor	11	Texaco-Casale	NG	54,000	.....
Arkansas	Lion Oil Company	El Dorado	12	NEC	NG	170,000	.....
Mississippi	Mississippi Chemical Co.	Yazoo City	13	AL	NG	58,500	28,500
	Spencer Chemical	Vicksburg	14	ANC	NG	63,000	.....
Tennessee	W. R. Grace and Co.	Memphis	15	Texaco-Casale	NG	72,000	.....
Florida	Gulf Chemical Co.	Pensacola	16	?	NG	.....	60,000
Alabama	T.V.A.	Muscle Shoals	17	TVA	NG	78,000	.....
	Ketona Chemical Co.	Ketona	18	?	CWG	.....	38,000
				Total Capacity		1,110,500	350,500

TOTAL NUMBER OF PLANTS

(a) Actual 13
(b) New plants or additions before 12/31/56 ... 7

Mid-Continent States:							
Kansas	Spencer Chemical	Pittsburg	19	NEC	NG	162,000	.....
	Coop. Farm Chemical	Lawrence	20	Texaco-Casale	NG	54,000	.....
Nebraska	Allied Chem. & Dye Corp.	La Platte	21	ANC	NG	63,000	63,000
Missouri	Hercules Powder	Louisiana	22	AL	NG	34,500	.....
Indiana	Standard-Sinclair Oil	Hammond	23	?	PRG	.....	90,000
Illinois	Mississippi River Fuel	Crystal City	24	Texaco	NG	.....	60,000
	National Distillers	Tuscola	25	Kellogg	BPE	.....	49,500
Kentucky	Spencer Chemical	W. Henderson	26	ANC	NG	65,000	.....
Ohio	Allied Chem. & Dye Corp.	South Point	27	ANC	CWG, NG	234,000	16,500
	Standard Oil of Ohio	Lima	28	Kellogg	PRG	.....	90,000
West Virginia	E. I. duPont de Nemours	Belle	29	AL-C	CWG	195,000	.....
	Olin Mathieson	Morgantown	30	AL-C-D	CWG	170,000	.....
	Columbia-South. Chem.	Natrium	31	NEC	BPC	.....	21,000
	Westvaco (Food Mach.)	S. Charleston	32	?	BPC	.....	18,000
Virginia	Allied Chem. & Dye Corp.	Hopewell	33	ANC	CWG, NG	287,000	41,000
Pennsylvania	Atlantic Refining	Point Breeze	34	HR	PRG	30,000	.....
	Sun Oil Company	Marcus Hook	35	?	PRG	.....	90,000
				Total Capacity		1,294,500	539,000

TOTAL NUMBER OF PLANTS

(a) Actual 10
(b) New plants or additions before 12/31/56 10

Northeastern States:							
Maine	Northern Chemical Ind.	Searsport	36	Texaco	FO	.....	37,500
Michigan	Midland Chemical Co.	Midland	37	FNRL	BPC	15,000	.....
	Penn. Salt Co.	Wyandotte	38	(Mt. Cenis / Casale)	BPC	24,000	.....
New York	Olin Mathieson Chemical	Niagara Falls	39	NEC	BPC	6,000	.....
	E. I. duPont de Nemours	Niagara Falls	40	FNRL	BPC	9,000	.....
				Total Capacity		54,000	37,500

TOTAL NUMBER OF PLANTS

(a) Actual 4
(b) New plants or additions before 12/31/56 1

Western States:							
Washington	Hooker Electro-chem. Co.	Tacoma	41	NEC	BPC	21,000	.....
	Columbia River Chem	Pasco	42	AL	FO (NG later)	.....	48,000
Utah	Utah Chemical Co.	Mt. Pleasant	43	?	NG	.....	82,500
	Salt Lake Chem.	Salt Lake City	44	Texaco	NG	.....	36,000
	U. S. Steel Corp.	Geneva	45	?	CWG	.....	60,000
California	Shell Chemical Co.	Pittsburg	46	Mt. Cenis	NG	90,000	.....
	Shell Chemical Co.	Ventura	47	Kellogg	NG	53,500	.....
	Dow Chemical Co.	Pittsburg	48	NEC	BPC	6,000	.....
	Bros Chemical Co.	Bros	49	MMC	NG	70,500	21,000
	Hercules Powder	Hercules	50	AL-H	PRG	41,000	.....
				Total Capacity		282,000	247,500

TOTAL NUMBER OF PLANTS

(a) Actual 6
(b) New plants or additions before 12/31/56 5

[1] **Process Code:**—AL—Air Liquide (Claude); AL-C—Air Liquide-Casale; AL-C-D—Air Liquide-Casale-du Pont; AL-H—Air Liquide-Hercules; ANC—Atmospheric Nitrogen Corporation; FNRL—Fixed Nitrogen Research Laboratory; HR—Hydrocarbon Research; MMC—Modified Mt. Cenis; NEC—Nitrogen Engineering Corporation; TVA—Tennessee Valley Authority; ?—Undecided or not announced.

[2] **Code for Source of H_2:**—BPC—By-product hydrogen from chlorine cells; BPE—By-product hydrogen from ethylene manufacture; CWG—Coke water gas; EW—Electrolysis of water; FO—Fuel Oil; NG—Natural Gas; PRG—Petroleum refinery gas; ?—Undecided or not announced.

percent of the total for the country, essentially equivalent to that for the period January 1, 1950, to December 31, 1954 (29 percent). Hence, it appears that the loss in capital investment in the southern states for the next two years, referred to the U. S. total, will be counteracted by a gain in investment in the western states. This fact confirms, of course, the data previously noted in Table 1, where it was shown that the decrease in southern state ammonia capacity in the next two years, as a function of the U. S. total, would be essentially offset by a gain in western state capacity.

Uses for Ammonia

The uses of this important chemical are shown in Figure 3. A detailed discussion of this chart cannot be given here, but some elaboration is needed.

Aside from direct employment of ammonia as such, which accounts for a wide diversity of applications, the uses of ammonia center around its organic and inorganic compounds. Outstanding among these is the use of ammonia for agricultural fertilizer, involving (beside direct application) use of organics such as urea, and the inorganics such as sulfate, nitrate and phosphate. The magnitude of the fertilizer market for nitrogen may be seen from the following statistics. During 1952 the fertilizer industry consumed 75 percent of the total fixed nitrogen produced in this country (1,400,000 tons out of the total 1,870,000). Of that 75 percent half was consumed by the southern U. S., a region made up of the seven ammonia-producing states comprising the "southern region" of Table 1, plus Virginia and Kentucky in the mid-continent region, plus the six currently non-producing southern states of North Carolina, South Carolina, Georgia, Florida, Arizona and New Mexico.

The high demand for fixed nitrogen by the fertilizer industry continued throughout 1953 and 1954. In 1953 the fraction of the total fixed nitrogen produced consumed by the industry was 74 percent (1,550,000 tons out of a total of 2,100,000). Bearing in mind the increasing importance of synthetic ammonia in the over-all picture, a large fraction of this fertilizer nitrogen requirement was accounted for by ammonia that was synthetic in origin. Complete data for 1954 are not yet available but indications are that 75-76 percent of the total fixed nitrogen produced will enter the fertilizer in-

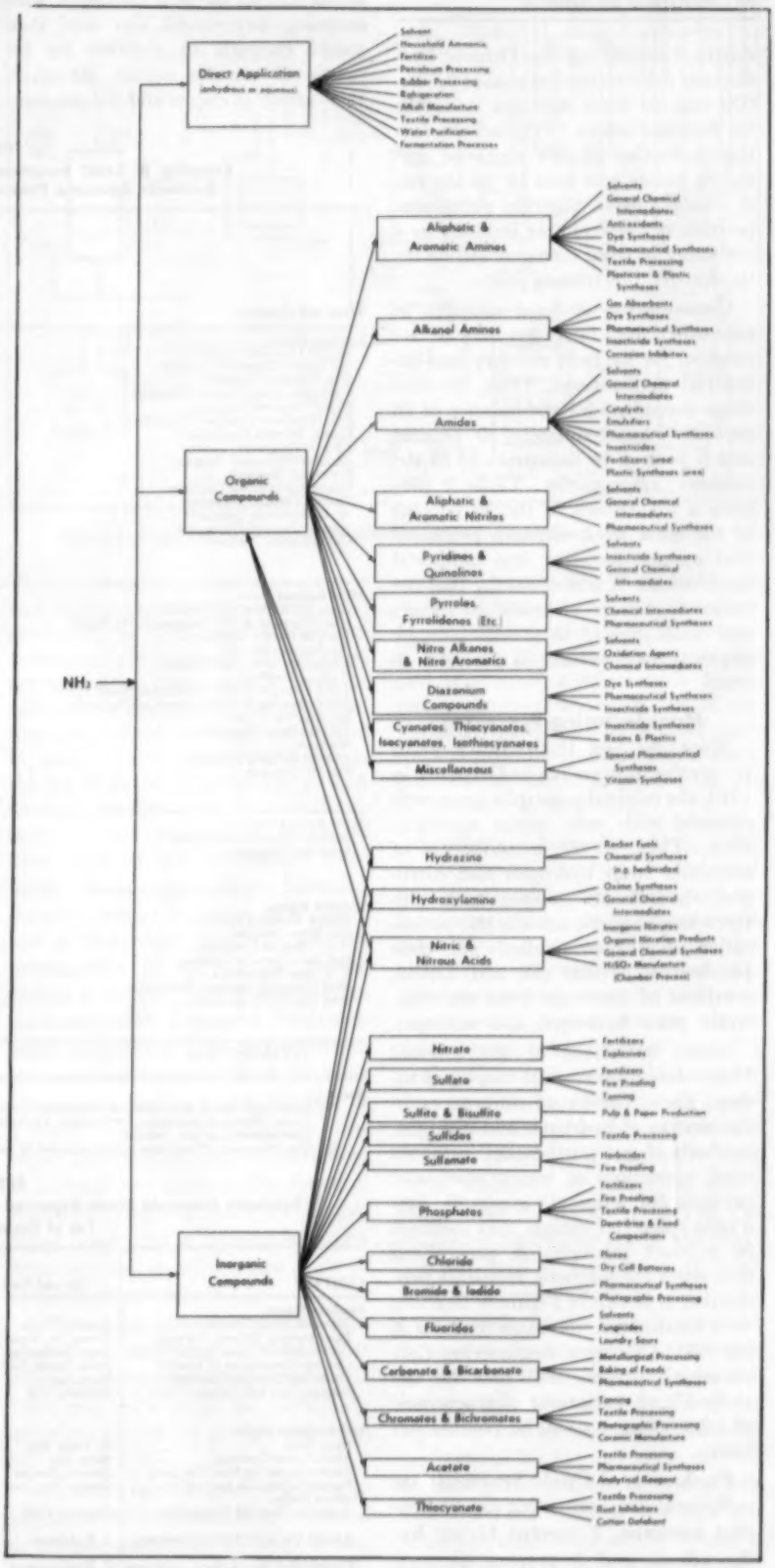


Figure 3. Pattern of major uses for ammonia and its compounds.

dustry. Considering the Defense Production Administration goal of 2,185,000 tons of fixed nitrogen available for fertilizer use in 1955, and the fact that a number of new synthetic ammonia plants will soon be on stream, it would appear that the prominent position of the fertilizer industry as a consumer of fixed nitrogen will be little changed this coming year.

Consumption of fixed nitrogen in uses other than fertilizers may be accounted for by both military and industrial applications. Thus, in 1953 these accounted for the balance of 26 percent — approximately 20 percent and 6 percent to industry and to the military, respectively. Table 2 presents a breakdown of the 20 percent of the total fixed nitrogen produced that apparently went into industrial applications. It is noteworthy that the major uses were chemical in nature and undoubtedly they will increase appreciably in volume in the years to come.

Manufacturing Processes

Since the first Haber-Bosch plant for synthetic ammonia in Germany in 1913, the original principles have been retained with only minor modifications. Thus, in the manufacture of ammonia from hydrogen and nitrogen, the process resolves itself into three major parts, namely the preparation of a crude synthesis gas, then purification of that gas, and, finally, synthesis of ammonia from the relatively pure hydrogen and nitrogen.

Many variations of the original Haber-Bosch process are employed today. These consist of differences in the sources of hydrogen and nitrogen, methods of gas purification, catalysts used, conditions of temperature and pressure for ammonia synthesis, ammonia converter design, and methods of product recovery. A generalized flow-sheet for synthetic ammonia production is shown in Figure 4. Starting with natural gas, the main features of the NEC (Nitrogen Engineering Corporation) process will now be described and variations characteristic of other processes will be pointed out later.

Production of Crude Synthesis Gas —Natural gas, containing say 91 percent methane, 7 percent higher hydrocarbons and 2 percent nitrogen plus carbon dioxide, is first heated to about 420 C. by heat exchange with outgoing processed gas and then passed through an absorber for removal of organic sulfur. Steam is then added in excess and the gas mixture at about 15 psig. passes on to the primary reformer. In this equipment, comprising vertical banks of tubes packed with a special nickel catalyst, reaction of methane with steam oc-

TABLE 5

Capacity & Total Investment for Installed & Proposed Synthetic Ammonia Plants in U. S. A. During 1950-56

	Period 1/1/50–12/31/54		Period 12/31/54–12/31/56	
Region and Company	New Capacity (Short Tons N/Year)	Approximate Investment for Complete Facilities (in $1000)	Proposed Capacity (Short Tons N/Year)	Proposed Investment for Complete Facilities (in $1000)
Southern States:				
Phillips Chemical Company	128,000	34,200	.....	.....
San Jacinto Chemical Company	36,000	3,000*	.....	.....
Dow Chemical Company	31,000	5,000	30,000	3,600
Chilleothe Petro-Chemical Company	.....	.....	56,500	17,000
United Chemical Company	.....	.....	47,500	18,000
Olin Mathieson Chemical Corporation	18,000	2,100	.....	.....
Comm. Solvents Corporation	55,000	15,000	.....	.....
Lion Oil Company	90,000	31,000	.....	.....
American Cyanamid Company	.....	.....	90,000	50,000
Deere and Company	54,000	18,000	.....	.....
Mississippi Chemical Company	58,500	13,000	28,500	2,000
Spencer Chemical Company	63,000	14,000	.....	.....
W. R. Grace and Company	72,000	20,000	.....	.....
Ketona Chemical Corporation	.....	.....	38,000	5,800
Gulf Chemical Company	.....	.....	60,000	22,900
	605,500	155,300	350,500	119,300
Mid-Continent States:				
Coop. Farm Chemical Company	54,000	15,000	.....	.....
Allied Chemical & Dye Corporation (La Platte)	63,000	25,000	63,000	10,000*
Hercules Powder Company	34,500	5,000	.....	.....
Standard-Sinclair Oil	.....	.....	90,000	9,000*
Mississippi River Fuel Company	.....	.....	60,000	15,000
National Distillers	.....	.....	49,500	7,000
Allied Chemical & Dye Corporation (South Point)	45,000	12,500	16,500	1,300
Allied Chemical & Dye Corporation (Hopewell)	45,000	12,500	41,000	7,800
Standard Oil of Ohio	.....	.....	90,000	17,000
Col.-Southern Chemical	.....	.....	21,000	3,030
Westvaco	.....	.....	18,000	2,500
Atlantic Refining Company	30,000	5,500	.....	.....
Sun Oil Company	.....	.....	90,000	9,000
	271,500	75,500	539,000	81,630
North Eastern States:				
Northern Chemical Industries	.....	.....	37,500	9,000
Penn. Salt Company	16,000	2,400	.....	.....
	16,000	2,400	37,500	9,000
Western States:				
Hooker Electro. Company	21,000	2,400	.....	.....
Col. River Chemical	.....	.....	48,000	12,000
Utah Chemical Company	.....	.....	82,500	18,725
Salt Lake Chemical Company	.....	.....	36,000	8,000
U. S. Steel Corporation	.....	.....	60,000	19,000
Shell Chemical Company (Ventura)	53,500	10,000	.....	.....
Brea Chemical Company	70,500	13,000	21,000	3,000*
	145,000	25,400	247,500	60,725
TOTAL for U. S. A.	1,038,000	$258,600	1,174,500	$270,655

Notes:
(1) Investment figures cover complete installation (i.e. for synthetic ammonia plus other chemicals to be made therefrom). Under "Proposed Investment for Complete Facilities" expansions at existing ammonia plants to cover chemicals other than ammonia are not included.
(2) The designation (*) indicates values estimated by author, since not located in the literature.

TABLE 6

Synthetic Ammonia Plants Reported to be Under Long-Range Consideration (as of December 31, 1954)

COMPANY	City and State	Map Code (Fig. 2)	Remarks
Southern States:			
Diamond Alkali Company	Houston, Texas	51	
Pan-American Refinery Company	Texas City, Texas	52	
Continental Oil-Cities Service Oil Co.	Lake Charles, La.	53	
Celanese Corporation of America	Baton Rouge, La.	54	$10,000,000 plant under consideration.
Delta Gas Chemical Corporation	Burns, La.	55	$9,000,000 plant under consideration.
Simpson Coal and Chemical Corp.	Natchez, Miss.	56	$20,000,000 plant under consideration (50,000 tons N/year, facilities also for acetylene and vinyl chloride).
Mid-Continent States:			
Lange Bros.	St. Louis, Mo.	57	$8,000,000 plant under consideration.
Atlas Powder Company	Atlas, Mo.	58	$6,750,000 plant under consideration.
Brown County Fertiliser Company	Reserve, Kansas	59	
Farmers' Coop. Oil Association	Orange City, Iowa	60	
Western States:			
Ammonia Chemical Corporation	Oleander, Calif.	61	$4,000,000 plant under consideration (30,000 tons N/year).
Arizona Gas and Chemical Company	?, N. Arizona	62	$3,000,000 plant under consideration, to use N_2 from wells.
Consolidated Min. & Smelt. Company	?, Washington or Oregon	63	$25,000,000 plant under consideration (75,000 tons N/year) using electrolytic H_2.

curs to form carbon monoxide and hydrogen. The reaction temperature of about 700 C. is maintained by combustion of additional natural gas outside the tubes.

Since the methane is not completely reacted in the primary, a secondary reformer is next employed. Advantage is also taken of this fact in that air may be added in sufficient quantity to supply the nitrogen for the process, essentially complete removal of oxygen occurring by combustion of the residual methane. Hence, in this secondary exothermic reaction over nickel catalyst at about 900 C., additional carbon monoxide and hydrogen are formed.

From the secondary reformer the exit gases pass through a waste heat boiler and then enter a carbon monoxide converter at 400 C. In this unit the monoxide is reacted with steam to form the dioxide and additional hydrogen, accomplished by passage of the gas over beds of iron oxide catalyst. The temperature rise is approximately 40 C. On leaving the converter the gases are cooled first by heat exchange to the incoming natural gas and then by direct contact with water. At this point the gases are at essentially atmospheric temperature and pressure, with a hydrogen:nitrogen molar ratio of 3:1. The flow is then directed to a gas holder prior to gas purification.

Purification of Crude Synthesis Gas—Removal of the gas impurities—about 15 percent carbon dioxide, 4 percent carbon monoxide and a trace of oxygen—is done at different pressure levels as the mixture is compressed to the ammonia synthesis conditions. The dioxide is first removed at about 225 psig. In early plants, and still today in numerous installations, water was employed for this purpose, the water being reclaimed and recirculated after power recovery from the pressure let-down. The trend today is toward use of ethanolamine solutions, however, the dioxide being expelled on heating and the amine cooled and recirculated. These latter solutions are more efficient for absorption, the carbon dioxide content in the scrubbed gas being less than 0.1 percent as compared with the 1-1.5 percent when using water.

Carbon monoxide is next removed at about 1800 psig employing a cuprous ammoniacal liquor as absorbent.

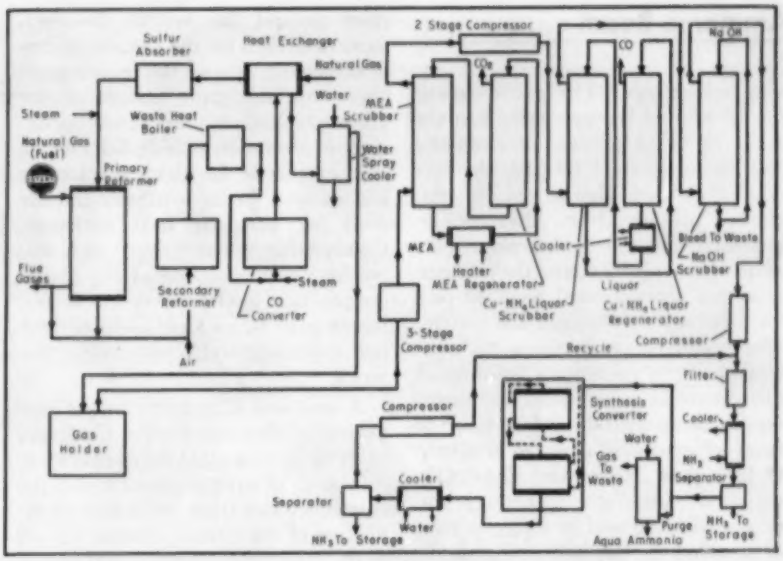


Figure 4. Diagrammatic flowsheet for ammonia synthesis (Generalized NEC process).

This is generally a mixture of cuprous and cupric ammonium formate and carbonate, as well as of ammonium carbonate; close control of the composition of this liquor is imperative for satisfactory operation. Absorption of the monoxide is accomplished at 0-5 C. and reduces its concentration in the gas to about 10 ppm. The carbon dioxide concentration is simultaneously further reduced to about 50 ppm., and oxygen is removed completely. Rich copper liquor from the absorber towers is passed to a generator section where it is heated to approximately 75 C., thereby losing carbon monoxide (and dioxide) from the loose chemical complex. This monoxide constitutes a by-product from the process, being utilized in most plants as a fuel and in some also as a supplement to the monoxide converter feed. It may also be considered as a cheap raw material for chemical synthesis. The regenerated copper liquor is adjusted in composition when necessary and is refrigerated prior to re-use in the absorbers.

Effluent gas from the copper liquor scrubbers is next scrubbed with dilute caustic solution (usually 5 percent) at 1800 psig. As a result the carbon dioxide content of the gas is reduced to 0-5 ppm.

In some plants a process known as methanation is employed for removal of carbon monoxide. In such a case the monoxide is reacted catalytically with hydrogen at 400-450 C. and up to 9000 psig, resulting in the formation of methane and water. Less equipment is required and power for pumping and regenerating solutions is eliminated; on the other hand part of the purified hydrogen is consumed and, for low pressure synthesis loops, more gas must be vented to control the inert methane in the loop.

Synthesis of Ammonia—In the NEC plants ammonia synthesis is conducted at approximately 5000 psig (330 atmospheres). Feed gas to the ammonia converter, comprising recycle gas plus fresh feed—all carefully treated (filtered and cooled) to remove oil, ammonia and water—enters the top of the converter with no more than 2.5 percent ammonia content. Flow is first directed downwards within the annulus of the shell and converter internals, thereby ensuring a reasonably cool shell. Then, by means of an interchanger set in the lower part of the converter, and tubes set in the catalyst bed itself in the upper, the feed undergoes countercurrent heat exchange with the hot leaving gases. At the top of the converter the mixture is directed downward through the catalyst bed. The temperature at the top of the bed averages 450 C., and at the bottom 525 C.; control is effected by having the hot leaving gases preheat the feed entering through the tubes just mentioned and by having a by-pass on the feed around the bot-

tom interchanger. The gases leaving the bottom of the converter contain some 12 to 15 percent of ammonia and are at nearly 4500 psig, the volume shrinkage giving rise to the marked pressure drop. After cooling in a condenser to condense about half of its ammonia content, the effluent gases are recompressed to 5000 psig for recirculation through the system. The necessary purge from the synthesis loop, to counteract build-up of such inerts as argon, neon and methane, is accomplished just prior to entry of synthesis gases to the converter; pure gases are generally scrubbed with water to recover ammonia which is sold in aqueous form or distilled to the anhydrous state.

The catalyst employed in ammonia synthesis is generally of the promoted iron type. Such a material, containing metallic iron and evenly distributed oxide promoters (e.g. 1 percent K_2O and 3 percent Al_2O_3), is in the form of porous granules. Calcium oxide is sometimes used in addition. Catalyst life may be as long as 4-5 years.

Anhydrous ammonia is stored in pressure vessels, usually spheres, prior to shipment. Railroad tank cars of 26 tons capacity are employed for transportation to the customer.

Variations in Ammonia Processes—As was mentioned earlier numerous variations from the original Haber-Bosch process are practiced in the U. S. today. The Haber-Bosch itself, with 200 atmospheres operating pressure and 550 C. temperature in the converter, leading to about 8 percent conversion to ammonia per pass, is not used without some form of modification. The NEC (essentially equivalent to the FNRL) process, with its 330 atmospheres and 500 C. giving about 20 percent conversion to ammonia per pass, has been described. Nine synthetic ammonia plants in the U. S. are currently using this process and 2 new plants are scheduled to employ it in the near future.

The Air Liquide or Claude process, with or without some modification, is being used by several companies in this country. Within the converter pressures up to 900-1000 atmospheres and temperatures of 500-650 C. are employed. In European applications several converters and condensers are operated in series, with no recycle of gases around the system; however, modern designs for the Claude process in this country retain the recycle principle. An important feature of the Claude technique is the converter design, a maximum of simplicity being used in spite of the high gas velocities encountered during synthesis and the need for adequate heat exchange. Catalyst life is quite short with this system when operating at the higher temperature levels; conversion to ammonia may be as high as 40 percent per converter or 85 percent for the series.

A modified Claude technique employed by Hercules Powder Company at its California plant uses single stage reforming of natural gas instead of the customary two stage. A further modification of the Claude process, known as the Casale, employs 500-900 atmospheres along with converter recycle and provision for more efficient heat transfer within the converter itself (using higher ammonia concentration in the recycle). Conversion per pass is in the range 20-40 percent. Du Pont, at its Belle plant, makes use of a process incorporating features of both the Claude and Casale processes.

Several synthetic ammonia plants currently in operation (and also under construction) employ the Kellogg process. The complete Kellogg design involves reforming at 100 psig and synthesis at 300 atmospheres in a modified type of converter; some plants use one or both features.

A relatively new type process which is receiving considerable interest at present from both ammonia companies and engineering firms is the Texaco, developed jointly by The Texas Company and Hydrocarbon Research, both of whom hold basic patents. The scheme involves first a partial oxidation of the feed stock hydrocarbon (e.g. methane in natural gas) with oxygen at pressures up to 400 psig, forming carbon monoxide and hydrogen. The monoxide is then converted to the dioxide in the usual shift reaction. After removal of the dioxide by monoethanolamine, residual monoxide and oxygen are removed by scrubbing with liquid nitrogen. The latter, as well as oxygen, stem from a liquid air installation. Synthesis of ammonia then follows using either the Claude or Casale technique. An important feature of the Texaco process is its inherent flexibility, being adaptable to hydrocarbon feeds ranging all the way from methane to heavy fuel oil.

Two other type processes of importance bear mention at this point. The Mont Cenis process (Shell Chemical Company, Pittsburgh, California) uses a synthesis pressure of no more than 100 atmospheres and a temperature of about 400 C. Methanation is employed to remove last traces of carbon monoxide, dioxide and oxygen prior to synthesis. Efficiency of conversion per pass is 9-20 percent. The ability of this process to compete with others at much higher pressures and temperatures is due to the special high activity catalyst employed, namely an iron cyanide complex. The Fauser process merits attention also. While not used in the U. S. it is only slightly different from the NEC technique, with synthesis at 200-300 atmospheres, and the hydrogen and nitrogen raw materials respectively obtained from water electrolysis and air liquefaction. Conversion per pass during synthesis is 12-23 percent.

The sources of hydrogen and nitrogen for ammonia synthesis have a considerable effect on process complexity and economics. In all cases nitrogen originates in air, whether it be secured directly by liquefaction or as a component introduced through combustion of say coke or a hydrocarbon with air. Hydrogen may be made directly by electrolysis of water or of sodium chloride. More indirectly hydrogen may be obtained by reforming natural gas and higher hydrocarbons, by the partial combustion of coke or hydrocarbons (even of fuel oil), and by recovery as a by-product from petroleum refining or manufacture of unsaturates such as ethylene or acetylene. Regardless of the source of the hydrogen by these more indirect methods, extensive purification, particularly to remove carbon monoxide, carbon dioxide and oxygen, is an absolute necessity prior to ammonia synthesis.

Original presentation was before the South Texas section of the American Institute of Chemical Engineers, Galveston, Texas, October 22, 1954.

LITERATURE CITED

Virtually all data given in Tables 4 and 5 were obtained from the following sources:

Petroleum Refiner, The Oil & Gas Journal, Petroleum Processing, Chemical Week, Chemical Engineering, Chemical & Engineering News, Chemical Market Abstracts (Foster D. Snell, Inc.), Agricultural Chemicals, Commercial Fertilizer, Farm Chemicals, The Wall Street Journal.

Shell's Stream Blending Plant is incorporated into the pump station just outside the refinery fence at Wood River. The refinery manufacturers only base stocks which are components of the products which are blended directly into the pipe line.

Blends Products in Pipe Line

At Shell's Wood River plant, petroleum products are automatically precision-blended as they enter the pipe line. It requires only a few seconds to change from product to product.

Rudy Lowe,
President, Proportioneers, Inc.,
Providence, R. I.

COMPLETED LAST YEAR, Shell Products Pipeline's Stream Blending plant at Wood River represents the final step towards eliminating batch processing. There blending is a continuous and automatic process. In addition, the plant goes one more step; in contrast with the few stream blenders which have been built before, the two installed at Wood River, Ill., delivers directly into the pipe lines which carry the gasoline and other products from the refinery to market.

The development came about as the result of an expansion of plant facilities. Normally such an expansion would require additions to the blending, shipping and seasonal storage tanks. As a means of conserving inventory space and reducing investment in tankage, Shell engineers investigated the possibility of blending base stocks and additives directly into the intake of the pipe line. It was clear that if this could be done successfully, there would be significant savings, not only in the number and size of tanks required, but also in the inventories of blended or partially blended stocks, and in the vapor losses which ordinarily occur during tank blending operations and the handling incident thereto.

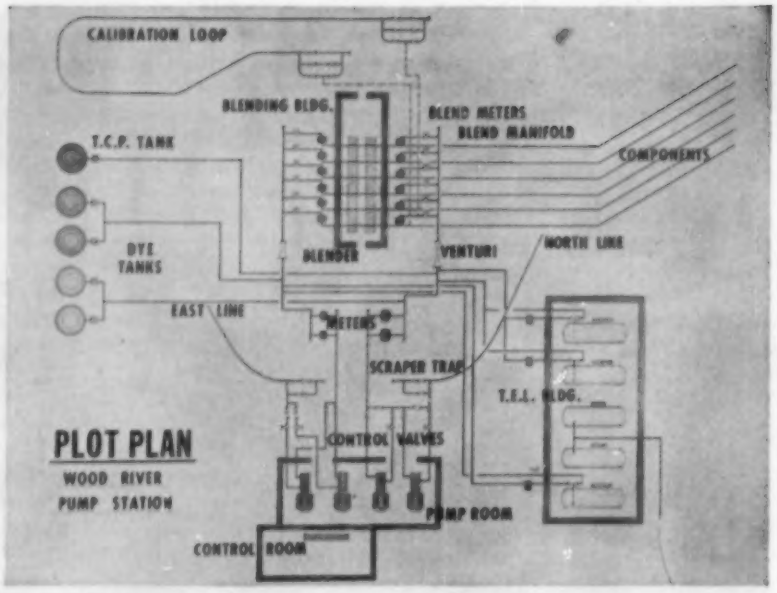
Other continuous blenders had been built previously for solvents, gasolines, lubricating oils, asphalts, fuel oil and the like, but in no case were the problems similar to those encountered in a pipe line operation. The problem which confronted the engineers in this case was that of designing a system in which each component was individually regulated to maintain a fixed percentage of the total flow, while the total flow was itself to be automatically regulated to match the variable intake requirements of the pipe line. In order to solve this problem, a number of new and novel features were required, the final design representing a composite of the efforts of Shell Products Pipe line and Proportioneers, Inc. engineering.

Stream Blending . . .

The conventional method of stream blending gasoline has been to use individual rate controllers consisting of a differential producer, an air instrument and an automatic control valve on each component stream. This method, however, required manual resetting of each flow rate whenever a change in total throughput was desired and this made it necessary to blend to an intermediate storage tank at constant rate because of the inability of such equipment to follow the varying pipe line demands.

The final blender as designed for pipe line service not only automatically follows pipe line requirements but also includes a built-in "memory" for each component stream so that shortages due to a tank switch or pump failure are recorded and can be made up during the transfer of a tender. An electrical supervisory system consisting of warning lights, limit switches and an audible alarm enable the operator to easily spot any failure in the component supply system and rectify the difficulty.

So many monitoring devices have been incorporated into the mechanism that it is virtually fool-proof. As an example, the meters which are of the positive displacement type (for pipe line accounting) can be calibrated and factored while in operation. This is accomplished by means of a "calibration loop" which is incorporated into the base stock feed system and manifolded in such a way that any meter can be calibrated with the particular stock it is handling without interrupting the blend. This "known volume" section of line can handle any component at the actual operating temperature, pressure and flow rate occurring during a blending operation. Since it forms a closed system, it is more flexible than the ordinary calibration tank and for the first time offers a means of calibrating butane streams.



Schematic diagram of the blending plant and pump station. Station suction pressure controls the master drive on the blending panel board.

Blending control panel board combines control of component streams, annunciation of trouble, off-blends, etc. A memory totalizer insures that proper amount of base stock, etc. will be pumped into line even though one of the component streams should fail temporarily.

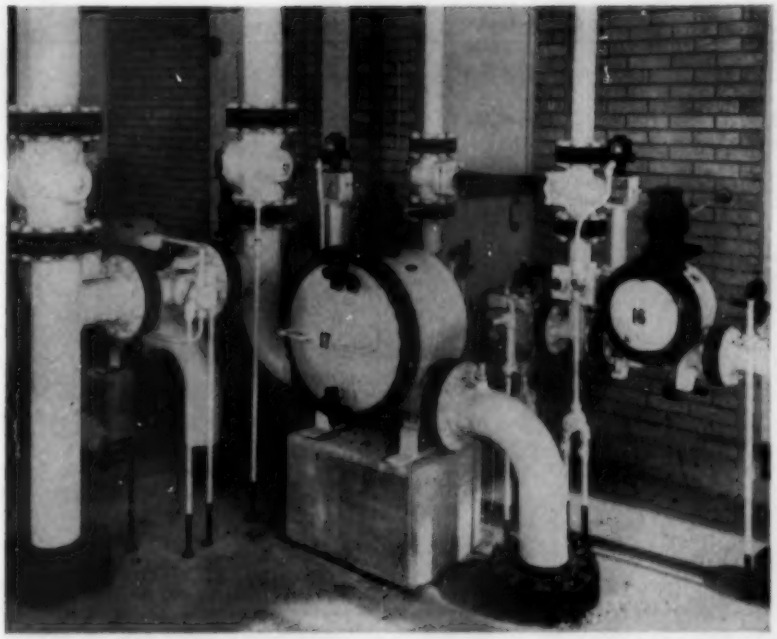
How It Works

Six base stock streams are handled and proportioned by the blender as well as tetraethyl lead, Shell's TCP additive, Shell's pipe line inhibitor, and two or more additives which cannot be named at this time. The major elements of the system are as follows:

(1) A computer system, which is primarily a motor-driven variable speed line shaft, governing the input to six variable ratio drives which separately set up the demand rates for each of the six component streams.

(2) The metering system, consisting of one or more positive displacement meters for each stream, sized to cover the range of rates which may be desired in any blend at any throughput.

(3) The mechanical tie between the meters and the computer system; this consists of a differential which identifies a slow or fast metering rate for each component, and converts this to a controlling action by a pneumatic instrument; this, in turn, governs the throttling action of the control valve handling that particular stream.



Positive displacement meters, located outside control room, measure various base stocks as they go into the suction of station. A shaft from each meter runs through wall to panel board.

(4) The master control, which operates from the pipe line station's suction pressure, and regulates the speed of the main computer shaft proportionately to the volume demand of the pipe line.

(5) Various monitoring lights and controls which signal failures in any part of the system. There are also component totalizers which register the delivered quantity of each component in terms of barrels of total delivery, and limit switches which sound alarms to notify the operator of any off-specification blend.

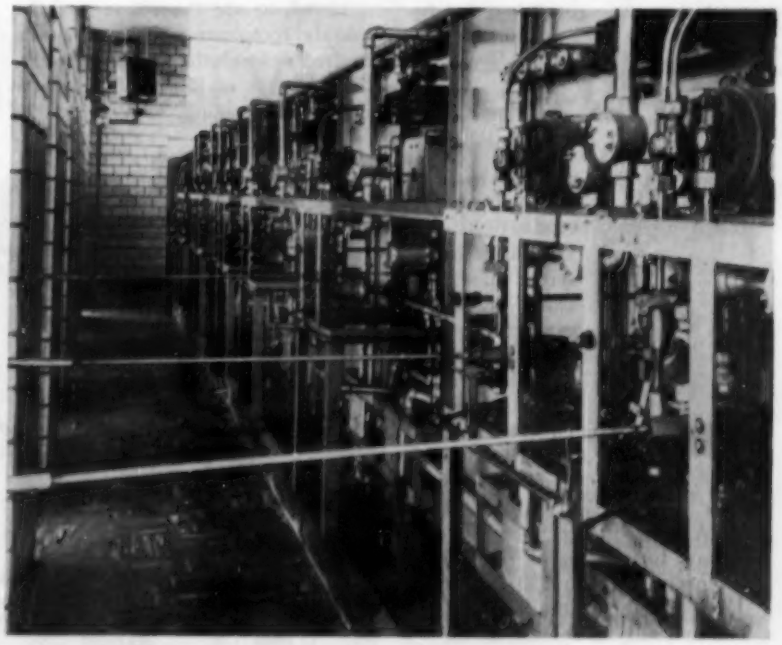
(6) The "memory" totalizers which also read in barrels and which are operated from the spider of the differential control unit. These totalizers make available the data of any component shortage caused by the momentary failure of a base stock stream and enable the operator to make up the deficiency following the sounding of the alarm.

(7) Automatic sample collectors which obtain weighted composite samples of the delivered blend at predetermined intervals.

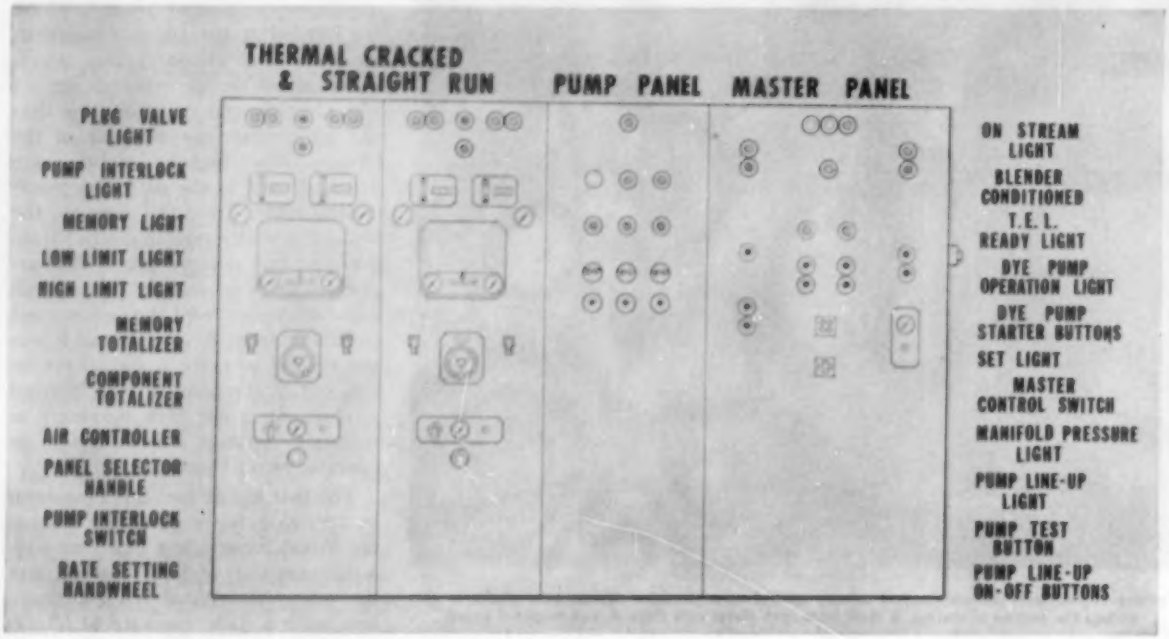
Operation is simple. Although this description may seem to make the blender sound complicated, it is actually very simple in operation. Before a run is scheduled, the operators are furnished with the blend composition for a given gasoline. The percentages of the various components are then determined based on the meter factors established by the calibration loop. These settings are made on the individual component panels, and from adjacent pump control panels, test starts are made on the respective component pumps, which are located at the refinery rundown tanks several thousand feet away. When all of the percentages are set and all of the test starts indicate that the components are available at the blender, the blender circuits are switched over to the pipe line pump control room. From this time on, the blender is under remote control from the pipe line pump station. This arrangement was chosen because all other deliveries from the refinery are controlled from this point, and it was not desired to make a special operation out of the delivery of a blended product. It is not even necessary to maintain constant attendance of an operator at the blender.

The two stream blenders have been in operation for a year, one serving the Wood River-Lima pipe line with a daily capacity of 38,000 barrels, and the other, the Wood River-Chicago line, with a daily capacity of 85,000 barrels.

When either of the two lines is pumping a product other than gasoline, its associated blender may be operated into tankage as a constant-rate system, by setting the master controller at the desired rate. Blends



Back of panel board showing shafts from individual meters. Should an insufficient amount of one of the component products enter line to station suction, the shaft from the meter on that particular line would slow down. Its rotation would be slower than the drive from the proportioning device. Through an instrument, this would signal the control valve on this particular products line to open and admit a larger stream to station suction.



Control panel for thermal cracked and straightrun gasoline shows advanced instrumentation.

made in this manner are then available for truck, barge, or tank car shipment.

All blends are made under pressure in a completely closed system; the turbulent flow conditions in the line insure all the mixing necessary; there are no evaporation losses. Experience has been that the component measurement is accurate to within 0.1 percent. The total blend volume is registered, as are the volumes of the separate components. No tankage is required beyond the rundown tanks, and the labor saving by the elimination of tank gaging, manual switching, and pump attendance, as compared with ordinary batch blending is a very significant contribution of this development. It is anticipated that this plant is but a forerunner of a new trend in refinery and pipe line operation techniques. ##

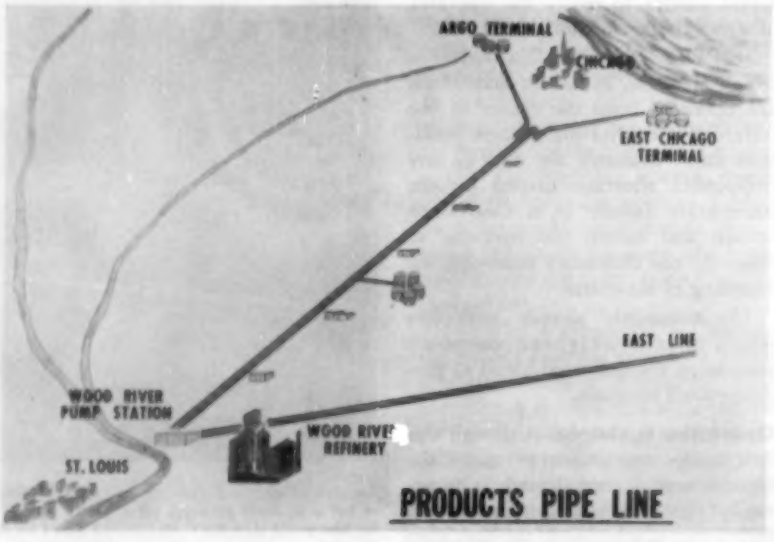
ACKNOWLEDGMENT

The author wishes to thank Sydney S. Smith, formerly of Shell Oil Company, now a consulting engineer, for his help in preparing this article.

Meet the Author

R. P. LOWE is founder of Proportioneers, Inc. Originally from London, he came to the U. S. in 1926, served in the Corps of Engineers, took B. S. and M. E. degrees from Illinois Institute of Technology, and spent ten years as chief engineer for Walter A. Ahlschlarger before he became president of Builders Engineers, Inc., in 1927. After the collapse of the building business in 1930, he became a consulting engineer in the waterworks field, and in 1932 started his present firm of proportioning engineers.

Lowe



Artist's sketch of Shell's products pipe line.

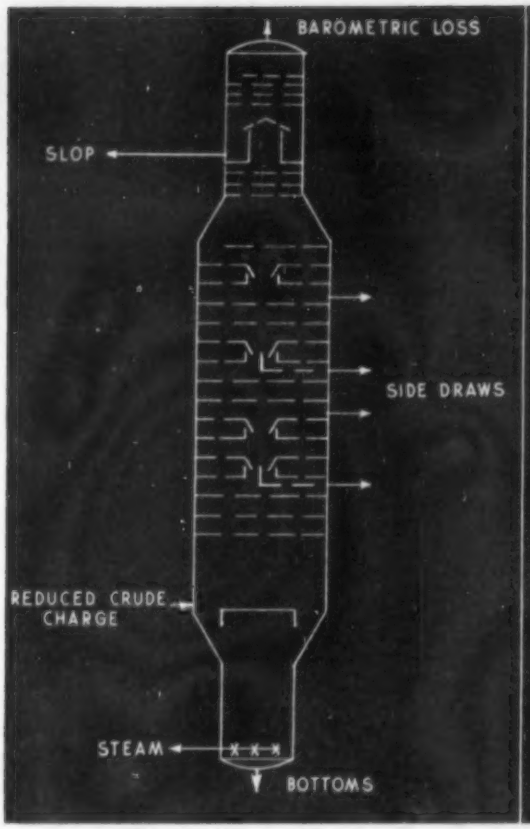


Figure 1. Tests were made on vacuum units of this design.

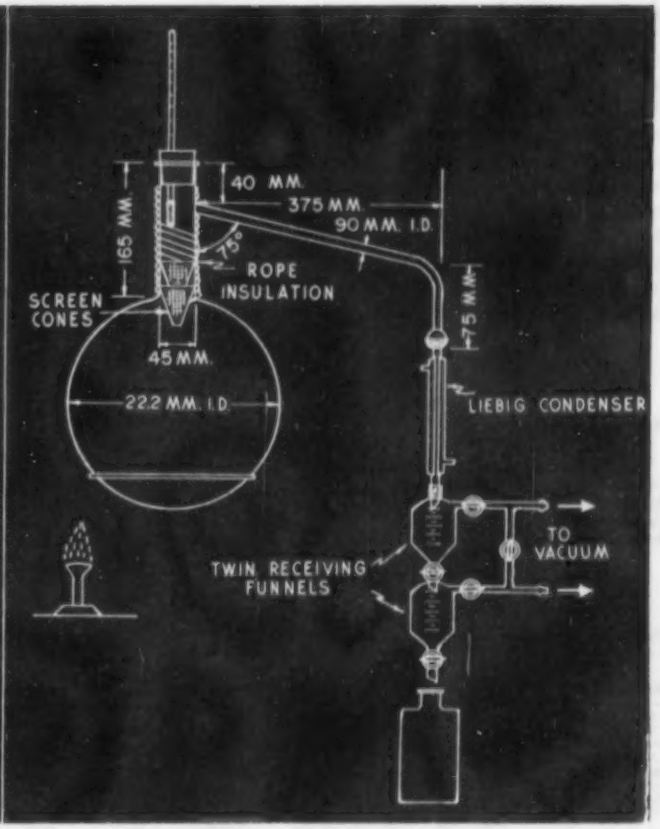


Figure 2. Laboratory distillation equipment: For calculations required.

Vacuum Flash: Actual Versus Calculated

Plant tests on vacuum columns show how percent flashed compares with calculations by well-known design methods.

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INCREASED INTEREST in low pressure flashing has promoted development of methods which enable the designer to estimate the quantity of materials that will be vaporized in a flashing chamber. The best known methods are those of Nelson and Harvey,[1] Edmister and Pollock,[2] Okamoto and Van Winkle,[3] and Okamoto and Van Winkle—TBP.[4] All four methods may be applied to distillations at pressures below atmospheric; however, low pressure extrapolation of Edmister and Pollock's correlations is not recommended by the authors (Edmister and Pollock).

The results obtained when using these four calculation methods are not identical, and in order to compare them with results obtained in commercial practice, several tests were made using conventional plant equipment. Every precaution was observed to keep the experimental error well within the limits of normal fluctuations encountered in routine refinery operations.

Three refinery vacuum towers, two of them of identical design, were used in this work. A sketch of these towers

is shown in Figure 1. Towers A and B have an internal diameter of eleven feet. They are equipped with four side strippers and lines for continuous withdrawal of a slop-cut and residual fraction. Steam is used in the bottom section of the tower, which has a diameter of five and one half feet, for removing all light fractions from the residuum before the residuum is withdrawn from the still. The flashing section of Tower C has a diameter of twelve and one half feet, and its bottom section has a diameter of six feet. The height of the flashing chambers within Towers A and B, and Tower C are six feet and twelve feet, respectively.

The instruments used for measuring the temperatures, pressures, and rate of flow of materials to and from the tower were tested for accuracy before each run was made. Equilibrium conditions within the units were established before each test, and each test consisted of eight to twelve hours of uniform unit operation. As an additional precaution the liquid on the first draw-tray above the flash chamber was removed at a rate sufficiently high to prevent overflow, thus minimizing the possibility of overflashing. Maximum variations in temperatures and pressures during the test periods did not exceed ±6 F. and ±10 mm. Hg., respectively. Samples from the unit

TABLE 1a
Test Data, Test Unit B

Flashing Conditions	
Pressure*	120 mm. Hg. abs.
Temperature	726 F
Steam to Flash Chamber	None
Overhead	4,002 b/d
Bottoms	1,428 b/d
Volume Flashed	74 percent
Reduced Crude Charge	Mixed-Base-1
Gravity	29.2 °API
Viscosity @ 210 F	53 S.U.S.
Conradson Carbon Residue	1.15 Wt. %
Sulfur	0.17 Wt. %
Cleveland Open Cup Flash Point	360° F

Vacuum Distillation @ 5 mm Hg. abs.

Percent Off	Vap. Temp. @ 5 mm °F	Gravity °API	Aniline No., °F	Refractive† Index	Correlation‡ Index
0- 5	350	42.1	172.9	1.4283	..
5-10	396	36.5	191.0	1.4426	19
10-15	416	34.7	197.6	1.4473	21
15-20	424	33.7	200.2	1.4496	22
20-25	436	32.9	205.5	1.4538	23
25-30	448	32.5	210.0	1.4548	23
30-35	462	32.2	211.3	1.4560	23
35-40	474	31.7	212.1	1.4572	23
40-45	488	31.2	215.6	1.4580	23
45-50	501	30.6	218.5	1.4590	24
50-55	518	30.1	221.7	1.4605	24
55-60	533	29.8	223.9	1.4623	24
60-65	548	29.2	226.8	1.4640	24
65-70	572	28.7	230.4	1.4663	25
70-75	585	28.1	231.4	1.4686	25
75-80	612	27.4	235.4	1.4708	25
80-85	628	26.5	237.9	1.4732	27
85-87.5	650	26.1	240.1	1.4753	28
12.5% Bottoms	...	21.6	....	.....	..

* Includes correction for steam. † Temp. = 170° F. ‡ See Literature Cited.

TABLE 1b
Test Data, Test Unit A

Flashing Conditions	
Pressure*	113 mm. Hg. abs.
Temperature	743 F
Steam to Flash Chamber	550 lb/hr
Overhead	5,435 b/d
Bottoms	3,905 b/d
Volume Flashed	58%
Reduced Crude Charge	Mixed-Base-2
Gravity	22.5
Viscosity @ 210 F	74 S.U.S.
Conradson Carbon Residue	2.68 Wt. %
Sulfur	0.54 Wt. %
Cleveland Open Cup Flash Point	355° F

Vacuum Distillation @ 5 mm Hg. abs.

Percent Off	Vap. Temp. @ 5 mm °F	Gravity °API	Aniline No., °F	Refractive Index	Correlation Index
0- 5	360	33.3	159.4	1.4555	..
5-10	391	31.0	175.0	1.4650	32
10-15	415	30.1	181.6	1.4660	32
15-20	432	29.5	186.0	1.4690	32
20-25	448	28.9	192.0	1.4700	33
25-30	464	28.4	193.4	1.4700	33
30-35	484	27.8	198.8	1.4730	33
35-40	498	27.0	202.4	1.4750	34
40-45	520	26.4	204.4	1.4775	34
45-50	538	25.7	207.6	1.4800	35
50-55	556	25.0	210.0	1.4820	35
55-60	580	24.4	212.0	1.4840	36
60-65	604	23.9	215.2	1.4870	36
65-70	634	22.6	217.0	1.4900	38
70-72.5	650	21.5	217.6	1.4930	40
27.5% Bottoms	...	12.9	....	.....	..

* Includes correction for steam.

TABLE 1c
Test Data, Test Unit C

Flashing Conditions	
Pressure*	35 mm. Hg. abs.
Temperature	753 F
Steam to Flash Chamber	4,250 lb/hr
Overhead	2,566 b/d
Bottoms	832 b/d
Volume Flashed	76 %
Reduced Crude Charge	Mixed-Base-2
Gravity	24.1° API
Viscosity @ 210 F	60 S.U.S.
Conradson Carbon Residue	4.14 Wt. %
Sulfur	0.57 Wt. %
Cleveland Open Cup Flash Point	320° F

Vacuum Distillation @ 5 mm. Hg. abs.

Percent Off	Vap. Temp. @ 5 mm °F	Gravity °API	Aniline No., °F	Refractive Index	Correlation Index
0- 5	290	39.1	141.4	1.4400	..
5-10	332	34.6	161.4	1.4530	29
10-15	362	32.4	171.6	1.4585	31
15-20	378	31.3	177.6	1.4630	32
20-25	410	30.3	182.4	1.4660	32
25-30	428	29.8	187.2	1.4690	32
30-35	442	28.9	191.4	1.4695	33
35-40	457	28.4	194.6	1.4710	33
40-45	478	27.6	198.4	1.4735	34
45-50	500	26.9	202.2	1.4750	34
50-55	522	26.0	205.6	1.4780	35
55-60	548	25.1	209.6	1.4810	35
60-65	572	24.8	211.6	1.4835	35
65-70	594	23.7	214.6	1.4865	37
70-76	632	23.2	213.0	1.4906	37
24% Bottoms	...	13.4	....	.....	..

* Includes correction for steam.

TABLE 1d
Test Data, Test Unit A

Flashing Conditions	
Pressure*	127 mm. Hg. abs.
Temperature	747 F
Steam to Flash Chamber	270 lb/hr
Overhead	3,488 b/d
Bottoms	4,712 b/d
Volume Flashed	43%
Reduced Crude Charge	Mixed-Base-3
Gravity	24.5 °API
Viscosity @ 210 F	82 S.U.S.
Conradson Carbon Residue	3.85 Wt. %
Sulfur	0.74 Wt. %
Cleveland Open Cup Flash Point	350° F

Vacuum Distillation @ 5 mm. Hg. abs.

Percent Off	Vap. Temp. @ 5 mm °F	Gravity °API	Aniline No., °F	Refractive Index	Correlation Index
0- 5	366	35.5	164.4	1.4470	..
5-10	407	32.3	181.2	1.4545	28
10-15	438	31.1	188.6	1.4598	28
15-20	456	30.3	193.8	1.4625	28
20-25	476	29.6	198.8	1.4630	28
25-30	492	28.9	203.4	1.4665	29
30-35	515	28.4	205.8	1.4670	29
35-40	532	27.9	209.8	1.4700	29
40-45	552	27.2	213.0	1.4712	30
45-50	570	26.6	215.6	1.4740	30
50-55	592	26.0	218.0	1.4755	31
55-60	608	25.6	219.0	1.4780	31
60-65	630	25.3	214.4	1.4790	31
65-70	648	25.0	213.0	1.4810	..
30% Bottoms	...	17.4	....	.....	..

* Includes correction for steam.

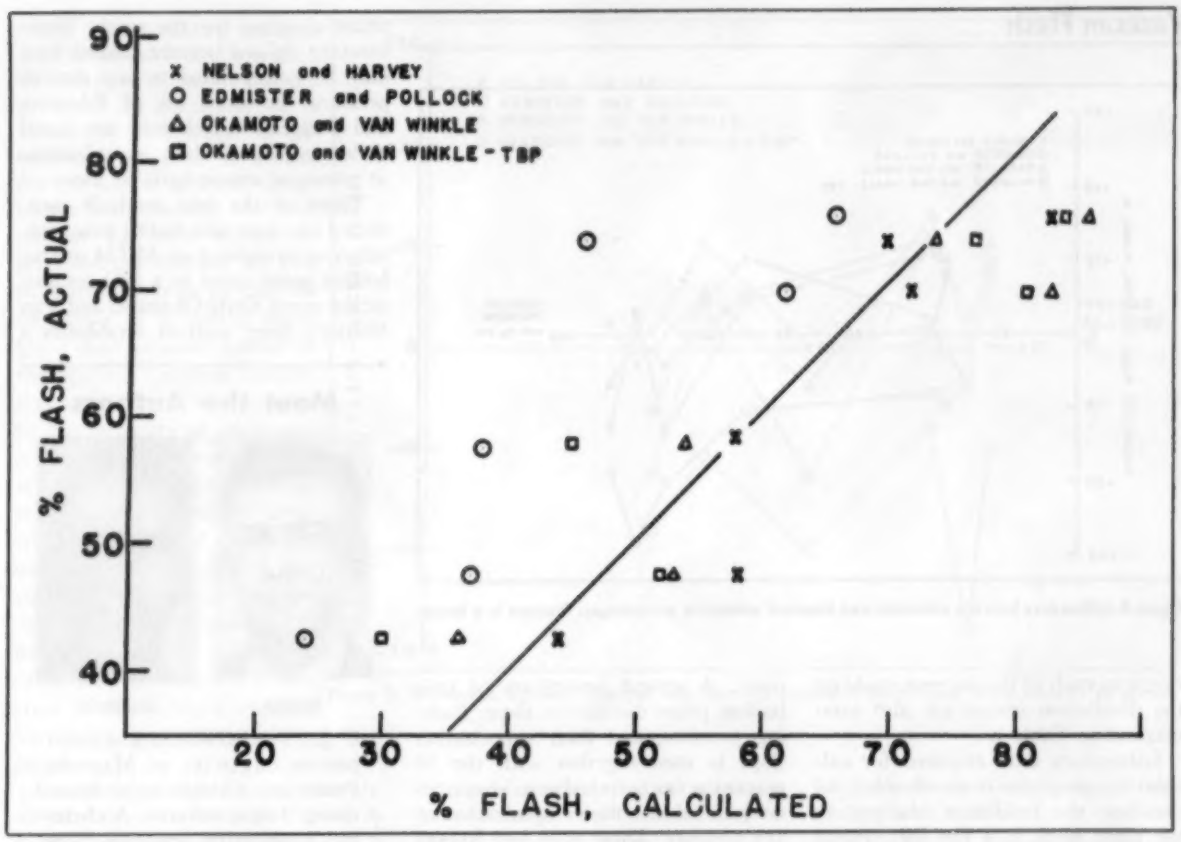

Figure 3. Actual versus calculated percent flash.

were secured every three hours and composited for laboratory analysis.

Residuums obtained from atmospheric distillation of four mixed-base and one asphalt-base crude oils were used in order to provide a variety of charge stocks for testing purposes. The data in Tables 1a-e show that none of these residuums exhibited abnormal distillation characteristics. The residuums were flashed at pressures ranging from 35 to 127 mm Hg. absolute and at temperatures ranging from 725 to 753 F. Volumes of materials vaporized in the flashing chambers varied from 42 to 76 volume percent based on charge. The experimental conditions and other data per-

TABLE 1e
Test Data, Test Unit A

Flashing Conditions	
Pressure*	90 mm. Hg. abs.
Temperature	747 F
Steam to Flash Chamber	360 lb/hr
Overhead	3,800 b/d
Bottoms	4,190 b/d
Volume Flashed	48%
Reduced Crude Charge	Mixed-Base-4
Gravity	22.4° API
Viscosity @ 210 F	84 S.U.S.
Conradson Carbon Residue	3.98 Wt. %
Sulfur	0.84 Wt. %
Cleveland Open Cup Flash Point	360 ° F

Vacuum Distillation @ 5 mm. Hg. abs.

Percent Off	Vap. Temp. @ 5 mm °F	Gravity °API	Aniline No., °F	Refractive Index	Correlation Index
0- 5	364	35.1	162.2	1.4470	
5-10	406	30.7	178.0	1.4616	32
10-15	431	29.3	181.8	1.4663	33
15-20	452	28.5	189.4	1.4686	33
20-25	470	28.1	193.2	1.4698	33
25-30	488	27.4	197.4	1.4718	34
30-35	500	26.9	200.0	1.4725	34
35-40	518	26.3	204.0	1.4750	34
40-45	531	25.6	204.6	1.4755	33
45-50	554	25.2	207.6	1.4790	35
50-55	568	24.7	208.8	1.4823	36
55-60	595	24.2	211.4	1.4848	35
60-65	616	23.5	211.4	1.4846	36
65-70	634	23.1	208.0	1.4862	36
70-75	650	22.7	204.6	1.4835	37
25% Bottoms	...	13.1	....	.....	..

* Includes correction for steam.

TABLE 1f
Test Data, Test Unit C

Flashing Conditions	
Pressure*	38 mm. Hg. abs.
Temperature	735 F
Steam to Flash Chamber	3,600 lb/hr
Overhead	2,730 b/d
Bottoms	1,170 b/d
Volume Flashed	70%
Reduced Crude Charge	Asphalt-Base
Gravity	20.1 °API
Viscosity @ 210 F	84 S.U.S.
Conradson Carbon Residue	2.20 Wt. %
Sulfur	0.35 Wt. %
Cleveland Open Cup Flash Point	270 °F

Vacuum Distillation @ 5 mm. Hg. abs.

Percent Off	Vap. Temp. @ 5 mm °F	Gravity °API	Aniline No., °F	Refractive Index	Correlation Index
0- 5	269	29.5	120.0	1.4600	
5-10	326	25.9	127.8	1.4730	53
10-15	367	24.4	141.0	1.4780	52
15-20	406	23.1	150.8	1.4810	52
20-25	434	22.3	160.0	1.4840	52
25-30	456	21.7	167.4	1.4855	52
30-35	475	21.3	172.4	1.4870	51
35-40	492	20.8	177.4	1.4885	52
40-45	510	20.5	180.0	1.4900	51
45-50	525	20.3	184.6	1.4910	51
50-55	535	19.8	187.2	1.4920	51
55-60	555	19.7	190.0	1.4925	51
60-65	569	20.2	196.0	1.4915	49
65-70	595	20.4	200.6	1.4920	47
70-75	616	20.6	205.6	1.4915	44
25% Bottoms	...	15.3	....	.....	..

* Includes correction for steam.

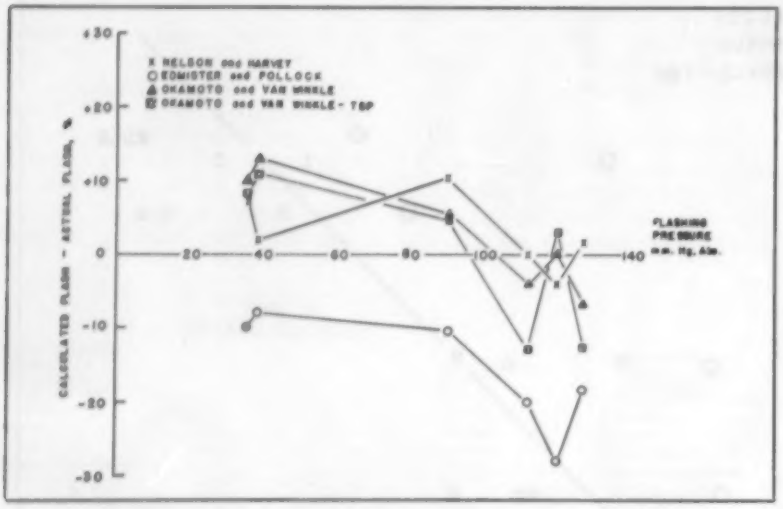

Figure 4. Differences between estimated and observed volumetric percentages: Pressure is a factor.

tinent to each of the six tests made on the distillation towers are also summarized on Table 1.

Laboratory data required for calculation purposes were obtained by distilling the residuums charged to the plant units in a five liter, round bottom distillation flask having an internal diameter of 22.2 mm. Other details of the laboratory distillation apparatus are shown in Figure 2. The flasks were insulated as shown in the figure. Two liters of oil under test were distilled at 5 mm Hg. pressure and at temperatures not exceeding 650 F. in order to avoid thermal decomposition. Vacuum distillation temperatures were corrected to atmospheric pressure.[5] The distillate was collected in five percent fractions by volume; and these fractions were tested for gravity, refractive index, and aniline number. The results of these tests are shown in Table 1.

The bases of methods used in this study for estimating the volume of materials flashed are as follows:

Okamoto and Van Winkle correlate ASTM distillation temperature, percent flashed, flashing pressure and flashing temperature. This correlation was derived from experimental laboratory flash vaporizations made on several stocks at pressures below atmospheric.

Okamoto and Van Winkle, in an earlier method, have correlated true boiling 50 percent point, flashing pressure, and flash vaporization 50 percent point. A second nomogram of true boiling point distillation slope, flashing pressure, and flash vaporization slope is used together with the 50 percent point correlation to obtain an estimate of the flash vaporization at any pressure. These slope and 50 percent point relationships are based on a theoretical analysis of hypothetical crude oils made by blending pure hydrocarbons to simulate actual crude oils.

Nelson and Harvey also plot ASTM distillation 50 percent point versus flash vaporization 50 percent point and ASTM distillation slope versus flash vaporization slope. These relations are derived from experimental work at atmospheric pressure, and flash vaporization curves are reduced to low pressures using vapor pressure curves for normal paraffin hydrocarbons.[6] Nelson and Harvey assume constant slope for the flash vaporization curve throughout all pressure ranges.

Edmister and Pollock show correlations using volume average boiling point, API gravity, ASTM distillation slopes, ASTM distillation 50 percent point and flash vaporization at 50 percent point to determine the critical point, a focal point, and a flash vaporization curve at atmospheric pressure. From the focal point, lines of constant volume percent flashed can be drawn through the proper points on the atmospheric flash vaporization curve, thus obtaining a phase diagram for the stock. These constant volume percent flashed lines may be extrapolated to any desired pressure; however, all of Edmister and Pollock's correlations are based on experimental flash vaporizations at pressures atmospheric or above.

Three of the four methods mentioned use slope and boiling point correlations to convert an ASTM or true boiling point curve to a flash vaporization curve. Only Okamoto and Van Winkle's later method establishes a

Meet the Authors

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GEORGE A. FILAK, until recently a process engineer for Magnolia Petroleum Company at its Beaumont, Texas, refinery, reported to Kelly Field, near San Antonio, Texas, this month to begin a tour with the Air Force. Filak joined Magnolia last August, following his graduation from Massachusetts Institute of Technology, where he studied business and engineering administration.

direct relationship between ASTM distillation, flash vaporization, and flashing pressure. All methods use a laboratory distillation at atmospheric pressure as a basis for conversion to flash vaporization temperatures. One reason for this basis is that experimental flashing at low pressures has been carried out on stocks of a boiling range lower than normally flashed on commercial vacuum distillation units. Error is introduced by the necessity of correcting a laboratory vacuum distillation to atmospheric pressure before any of the above methods can be applied to the reduced crude oils tested. A correlation of laboratory vacuum distillation temperatures with flash vaporization temperatures would eliminate any error in correcting a vacuum distillation to atmospheric pressure.

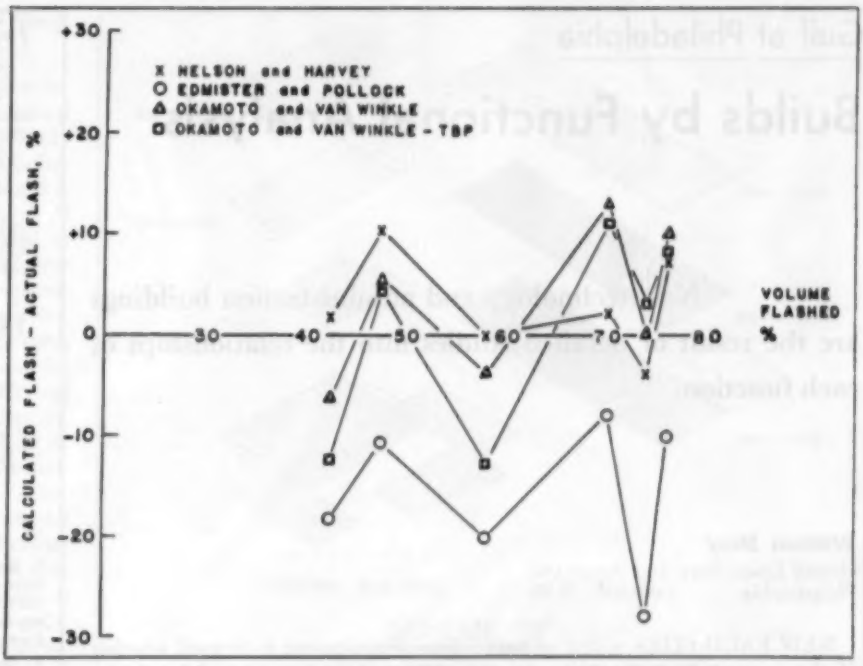

Figure 5. Differences between estimated and observed volumetric percentages: As a function of percent flashed.

Comparisons of calculated and observed data are shown in Figures 3, 4, and 5. Figure 3 compares, by percent, actual volume of material flashed with calculated volume. In Figures 4 and 5 the differences between the estimated and observed volumetric percentages of materials flashed are plotted against pressure and percentages flashed, respectively.

Inspection of these plots shows the following:

(1) Volumes of materials flashed in commercial equipment are within ± 13 percent (based on charge) of those calculated by the methods of Nelson, Okamoto and Van Winkle, and Okamoto and Van Winkle—TBP. The cauculated values for these methods are higher than the observed values at pressures below 100 mm Hg. and the same or lower at higher pressures. The differences between observed and calculated values are of about the same magnitude as those of other engineering calculations involved in tower design. Values calculated by Edmister and Pollock are lower than those observed in plant equipment.

(2) The two methods developed by Okamoto and Van Winkle appear to give similar results. Within the ranges investigated, Nelson and Harvey's method seems to be capable of predicting the volume of material flashed with a somewhat higher accuracy than the other methods studied (see Table 2).

(3) Selection of the method for calculating the volume of materials flashed in a commercial tower depends to a certain extent on the basis of such calculations. If the percentage of charge stock flashed is used as a basis for calculating flash temperature or pressure, positive deviations in Figure 5 will result in a lower heat input or a higher pressure level than that which is required. Conversely, negative deviations in Figure 5 will result in oversizing equipment.

Original presentation was made at the Second Annual Joint Technical Meeting sponsored by the AIChE Sabine Area Chapter and the ACS Texas-Louisiana Gulf Section, Beaumont, March 4, 1955.

ACKNOWLEDGMENT

The authors are indebted to the Magnolia Petroleum Company for permission to present this paper and to V. A. Kalichevsky for valuable assistance during its preparation.

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TABLE 2

Deviation

(Deviation = Estimated % Flashed—Actual % Flashed)

Vacuum Unit	Reduced Crude	Nelson and Harvey	Okamoto and Van Winkle	Okamoto and Van Winkle—TBP	Edmister and Pollock
C	Asphalt-Base	2	13	13	−7
	Mixed-Base-2	7	10	8	−10
A	Mixed-Base-2	0	−4	−13	−20
	Mixed-Base-3	2	−7	−13	−19
	Mixed-Base-4	11	−6	4	−11
B	Mixed-Base-1	−4	0	3	−28
	Average	4	7	9	16
	Range	−4 to +11	−7 to +13	−13 to +11	0 to +28

Gulf at Philadelphia

Builds by Functional Analysis

New technology and administration buildings are the result of detailed studies into the relationships of each function.

William Shay
Howell Lewis Shay and Associates
Philadelphia

NEW FACILITIES added as part of the company's recent $50 million expansion program at Girard Point, in Philadelphia, have made Gulf Oil Corporation's Philadelphia refinery the largest oil refinery on the East Coast. The refinery's capacity has been increased by 75 percent and gives the plant a total thruput of 183,000 barrels per day.

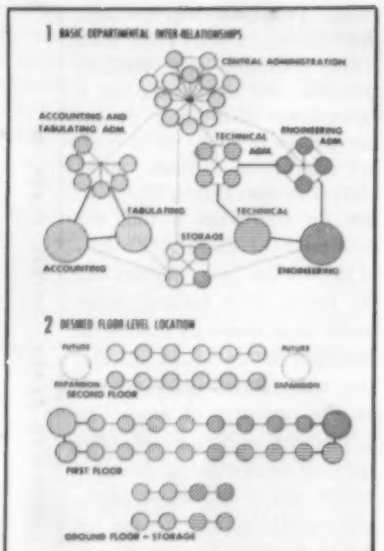
Expansion of refinery operations on this scale naturally dictated an accompanying expansion of laboratory facilities.

As a vital part of this vast expansion program at Philadelphia, Gulf greatly expanded its Refinery Technology Laboratory. Here, the Corporation conducts routine testing for the control of day-to-day operation of the Philadelphia refinery as well as control and testing services for the entire Corporation. Its expansion was accomplished by enlarging and better relating all of the laboratory facilities in an existing building and constructing an additional building to house administrative personnel, special laboratories, shipping, maintenance, and storage facilities.

Determining the Scope—Successful planning of any laboratory can only begin with a complete analysis and understanding of the scope of the anticipated program. The architect and engineer must confer at length with the owner on such vital matters as the estimated size of the program in terms of laboratory personnel, the type of equipment to be used, whether additional work is planned for the future at the same laboratory location; in short, as complete a picture as possible of the activities for which the laboratory must provide.

Gulf's laboratory control program is closely integrated with activities at each refinery, although the Refinery Technology Laboratory (RTL) operates as a distinct and separate division of the Manufacturing (refining) department. This laboratory provides technical service for other major divisions of the company and participates in the technical activities of other Gulf departments. Designation of the division of laboratory activities among the company's entire program, therefore, was of primary consideration.

About 60 percent of the total laboratory operations at RTL were determined as relating to refinery control problems at the Philadelphia and other refinery installations. This is the phase of laboratory operations having to do with quality control of the actual manufacture of fuel oil, lubricating oil, gasoline, and other petroleum products. Expanded laboratory facilities were required at RTL to handle the increased work load, such as testing of crude oil samples to determine the best refining methods, evaluation of all crude oil entering the refineries, development of specifications for all Gulf products, and control testing necessary for the production of quality products.



1. Graphic portrayal shows the desired inter-relationship of the several operations (administration, accounting, tabulating, engineering, laboratory and storage) strictly from an operational standpoint.

2. These basic relationships are arranged by desired floor level location of the various elements. With these considerations fully established, plans can be carried out to embody the basic operational concept.

Figure 2. Architect's analysis of the new administration building.

Gulf's Domestic and Foreign Marketing departments absorb another 30 percent of the laboratory's technical effort. This program embraces extensive testing and evaluation, not only of competitive products throughout Gulf's marketing territories, but also periodical check-ups on Gulf's own branded products in these areas. This program represents a follow-through of the quality control activities of the Corporation in order to assure its customers of the finest products possible. In carrying out this extensive program, the laboratory has been equipped with some of the most modern and finest analytical equipment obtainable. A modern test engine laboratory is equipped to run conventional octane tests; it also has chassis dynamometers and other specialized test equipment for L-1, L-4 and FL-2 tests.

In the Product Development section of RTL, technicians work constantly to improve Gulf's line of lubricants and greases for the automotive and industrial markets. Specialized properties are incorporated into various grades.

The Refinery Technology Laboratory also prepares many varieties of

additives used by Gulf in its products.

Gulf's Technical Program—In the case of Gulf, many of these technical activities had been housed previously in a four-story brick laboratory building adjacent to the Philadelphia Refinery. This building, which is 25 years old, has had utilities added in a somewhat octopus fashion to meet the emergency needs of the expanding laboratory's scope of activity, with the result that the electric services had become overloaded, and the steam, gas, water, and sewer services were not up to the required capacity. Efforts to increase the capacities of these services had not proved practical, since the lines were buried beneath the concrete floors of the building. Space for both laboratories and offices was at a premium, so that certain laboratory work requiring temperature control was handicapped, and departments were overlapping. Air conditioning, so necessary for certain laboratory tests, could not be installed, nor was space available for new apparatus. Shipping and storing of samples had to be carried on in a separate temporary building; barrels and drums had to be stored outside. The Analytical and Testing section, the Mechanical Testing section, etc., were overcrowded. Areas generally were not properly lighted.

The approach to the problem of more space and facilities was through functional analysis—a simple study of the size, function and relationship of each element. First, the RTL reduced its thinking to a layout for remodeling the present structure and for a new related storage building. The architect then analyzed the problem by the use of simple ball and line diagrams (See Figure 2). The final scheme, after consultation with department heads, is shown in Figure 1.

As an example of improvements to the old building that became possible at relatively low costs, it was agreed that electrical, gas, steam, and water lines could best be improved by installing completely new lines close to the ceilings and simply sealing off the outmoded lines beneath the floors. As a result, new lines are easy to reach, adapt, and service.

It was not possible to install a building-wide air conditioning system in the old laboratory because of structural limitations beyond our control. However, as non-laboratory space was made available for laboratory use, it was possible to set up localized air conditioning within those areas where temperature and humidity control were essential.

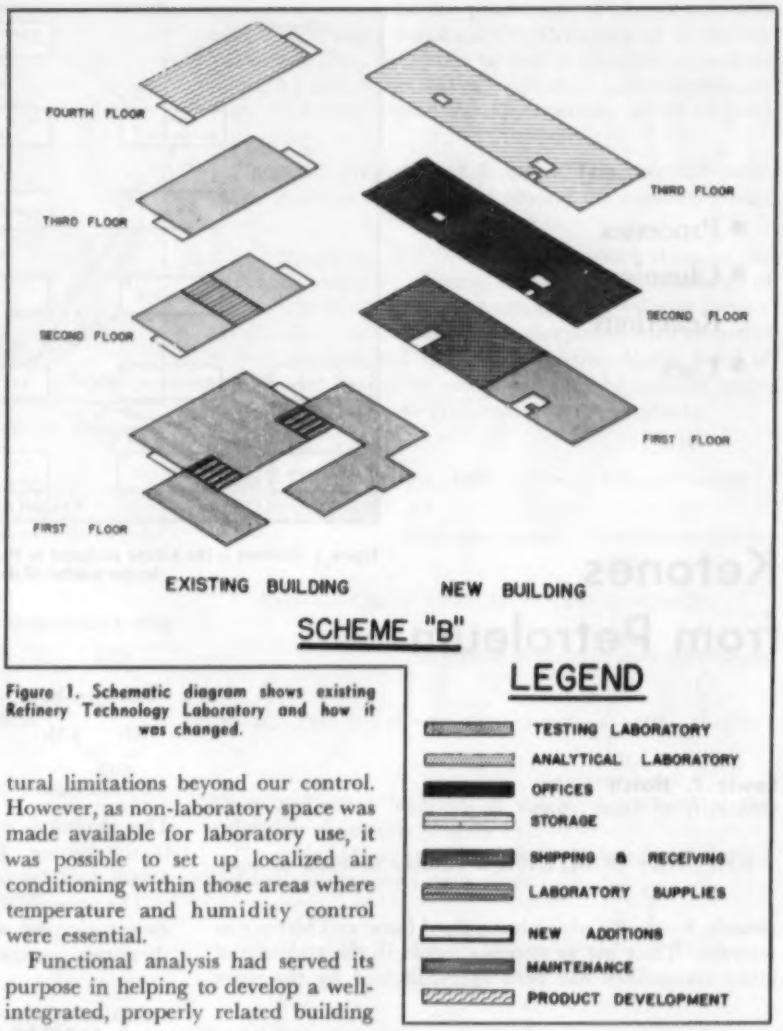


Figure 1. Schematic diagram shows existing Refinery Technology Laboratory and how it was changed.

Functional analysis had served its purpose in helping to develop a well-integrated, properly related building program.

In addition to the laboratory expansion work, the enlarging of the over-all refinery demanded the construction of a new refinery administration building. Here also we were presented with a carefully-thought-out digest of space requirements prepared by Gulf's engineers and department heads. Again through functional analysis, the architect with the department heads analyzed each department to establish relationship to each other and to the whole. Once these were established and areas determined, the plan almost automatically took the proper form. The center portion developed into a two story building with basement, with side wings one story high, but designed to receive a second story. Administrative offices were located in the center portion, with a mailing room and storage space in the basement; the accounting section was located in one wing, with the Technical Service Division and Drafting Room in the other wing.

Figure 2 shows two of the basic diagrams produced in the development of the functional analysis of this problem.

The exterior of each building is predominantly brick, cast stone, and aluminum which does, in fact, blend with the surrounding structures as intended. They contain awning type of aluminum windows that offer exceptional ease of operation and an abundance of daylight. Venetian blinds complete the appearance and control the admission of light.

Inside the building, visitors and employees work in an atmosphere of warm cordiality achieved through airy, muraled lobbies and color combinations that enhance the appearance of every area. ##

- Processes
- Chemical Reactions
- Uses

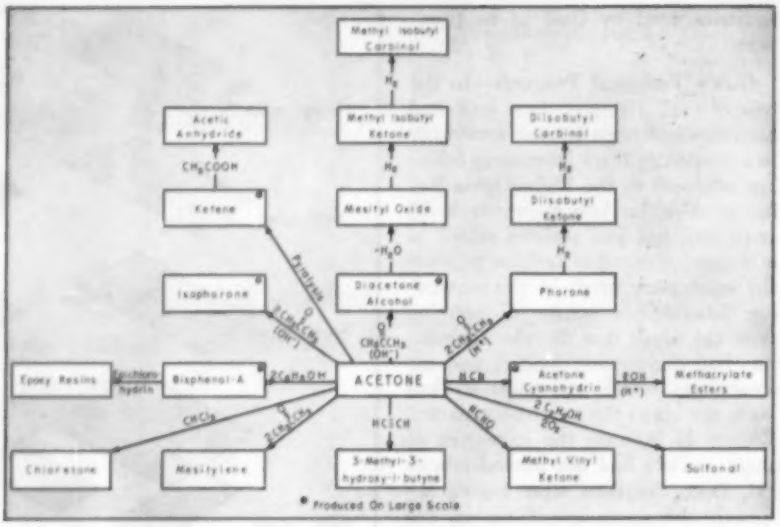


Figure 1. Acetone is the ketone produced in the largest amounts. Its versatility is indicated here by the number of its chemical derivatives.

Ketones from Petroleum

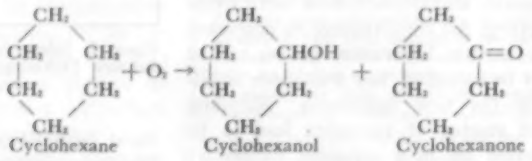
Lewis F. Hatch
University of Texas, Austin

KETONES COMPRISE a family or class of compounds, $R-\overset{O}{\overset{\|}{C}}-R$, which has gained fame and fortune as solvents. Their use as stepping stones in the synthesis of other compounds has been overshadowed by the more reactive aldehydes, $R-\overset{O}{\overset{\|}{C}}-H$. Times are changing, however, and at last ketones are being produced not so much for themselves alone as for the compounds which can be made from them.

Acetone, the greatest of them all, is now utilized more as a raw material for synthesis than as a solvent. Many of the compounds made from it are in turn used both as solvents and for the production of still other compounds.

General methods for ketone production. All ketones are petrochemicals but with varying degree of consanguinity. The method of production presenting the closest relationship is direct oxidation of paraffin hydrocarbons. Celanese Corporation of America, Chemical Division, at its Pampa, Texas, plant oxidizes butane at a relatively high pressure and low temperature over a catalyst. Acetic acid is the major product, but both acetone and methyl ethyl ketone are listed as primary products along with a number of aldehydes, alcohols and acids.

The oxidation of cumene to phenol and acetone (Figure 2) is another oxidation process in which acetone is a by-product. This process is one step removed from petroleum raw materials since the cumene is produced from benzene and propylene. Cyclohexane is air oxidized in the liquid phase using a cobalt acetate catalyst to give a mixture of cyclohexanol and cyclohexanone.



The alcohol is separated from the ketone and oxidized to the ketone. Cyclohexanone is further oxidized to adepic acid for use in the production of nylon.

The primary source of ketones is the oxidation or dehydrogenation of secondary alcohols or a combination of these two processes.

Oxidation: $2CH_3CHOHCH_3 + O_2 \rightarrow 2CH_3-\overset{O}{\overset{\|}{C}}-CH_3 + 2H_2O$
Isopropyl alcohol — Acetone

Dehydrogenation: $CH_3CHOHCH_3 \rightarrow CH_3-\overset{O}{\overset{\|}{C}}-CH_3 + H_2O$

The alcohols are produced by the hydration of the corresponding olefins; thus this method of ketone production is at least once removed from petroleum raw materials.

Olefins may also serve as a starting material for ketones through the Oxo reaction.

$2CH_2=CH_2 + CO + H_2 \rightarrow CH_3CH_2-\overset{O}{\overset{\|}{C}}-CH_2CH_3$
Ethylene — Diethyl ketone

This reaction apparently is of importance only with ethylene.

The higher boiling ketones such as diacetone alcohol, mesityl oxide and isophorone are condensation products of acetone or derived from them, and their production accounts for a considerable fraction of total acetone production. These compounds have a "kissin' kin" relationship to petroleum hydrocarbons.

Aromatic and alkyl aromatic ketones are used to some extent as high boiling solvents and in the synthesis of other compounds. They are usually prepared by a Friedel-Crafts reaction. Under the proper conditions either acid

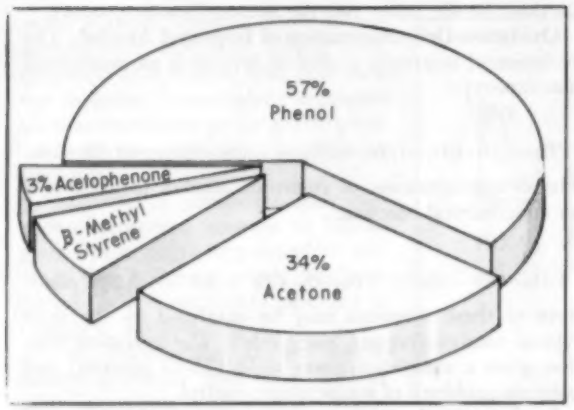


Figure 2. Product distribution (weight percent) from the oxidation of cumene.

chlorides, $\left(R-\overset{O}{\overset{\|}{C}}-Cl\right)$ acid anhydrides $\left(R-\overset{O}{\overset{\|}{C}}-O-\overset{O}{\overset{\|}{C}}-R\right)$ or acids $\left(R-\overset{O}{\overset{\|}{C}}-OH\right)$ may be used as the alkylating agent in the presence of aluminum chloride.

$$CH_3-\overset{O}{\overset{\|}{C}}-Cl + C_6H_6 \rightarrow CH_3-\overset{O}{\overset{\|}{C}}-C_6H_5 + HCl$$

Acetyl chloride Benzene Acetophenone

$$CH_3-\overset{O}{\overset{\|}{C}}-O-\overset{O}{\overset{\|}{C}}-CH_3 + C_6H_6 \rightarrow CH_3-\overset{O}{\overset{\|}{C}}-C_6H_5 + CH_3-\overset{O}{\overset{\|}{C}}-OH$$

Acetic anhydride

$$CH_3CH_2-\overset{O}{\overset{\|}{C}}-OH + C_6H_6 \rightarrow CH_3CH_2-\overset{O}{\overset{\|}{C}}-C_6H_5 + H_2O$$

Propionic acid Propiophenone

Acetophenone is a relatively expensive compound (*ca.* 75c/lb.) and has been produced to the extent of only 2 million pounds per year. It is a by-product of the cumene oxidation process for the production of phenol and acetone (Figure 2). Standard Oil Company of California (Oronite) plant using this process is reported to produce about 3.5 million pounds of by-product acetophenone per year. This new source should materially affect its price and uses.

Chemical Properties of Ketones. The chemical properties of ketones are centered around the carbonyl group, $R-\overset{O}{\overset{\|}{C}}-R$, and the activating influence which it has on the hydrogen atoms on adjacent carbon atoms. Nearly all of the commercially important reactions of ketones involve an addition reaction between a compound with an active hydrogen atom and the carbon-oxygen double bond of the ketone. The other compound may be another molecule of the ketone to give condensation products.

$$CH_3-\overset{O}{\overset{\|}{C}}-CH_3 + HCN \rightarrow CH_3-\overset{OH}{\overset{|}{C}}(CN)-CH_3$$

Hydrogen cyanide Acetone cyanohydrin

$$CH_3-\overset{O}{\overset{\|}{C}}-CH_3 + HC\equiv CH \rightarrow CH_3-\overset{OH}{\overset{|}{C}}(CH_3)-C\equiv CH$$

Acetylene 3-Methyl-3-hydroxy-1-butyne

$$CH_3-\overset{O}{\overset{\|}{C}}-CH_3 + CH_3-\overset{O}{\overset{\|}{C}}-CH_3 \rightarrow CH_3-\overset{OH}{\overset{|}{C}}(CH_3)-CH_2-\overset{O}{\overset{\|}{C}}-CH_3$$

Diacetone alcohol

These and other reactions of this type are used in the utilization of acetone (Figure 1).

The carbonyl oxygen atom can be replaced by halogens and various ammonia derivatives.

$$CH_3-\overset{O}{\overset{\|}{C}}-CH_3 + PCl_5 \rightarrow CH_3-CCl_2-CH_3 + POCl_3$$

Phosphorus pentachloride 2,2-Dichloropropane

TABLE 1 Ketones: Physical Properties

NAME	FORMULA	Molecular Weight	Boiling Point °C	FLASH POINT °F		Vapor Pressure (mm) 20° C	Pounds per Gallon 20° C
				Open Cup	Closed Cup		
Acetone	$CH_3\overset{O}{\overset{\|}{C}}CH_3$	58.1	56.1	Below	—4°	186.2	6.59
Diacetone Alcohol	$(CH_3)_2C(OH)CH_2\overset{O}{\overset{\|}{C}}CH_3$	116.2	169.1	170†	....	1.1	7.82
Mesityl Oxide	$(CH_3)_2C=CH\overset{O}{\overset{\|}{C}}CH_3$	98.1	129.5	98°	79°	8.0	7.11
Methyl Isobutyl Ketone	$(CH_3)_2CHCH_2\overset{O}{\overset{\|}{C}}CH_3$	100.1	115.9	81°	60°	15.2	6.67
Isophorone	$CH_3C(CH_3)_2CH_2C(CH_3)=CH\overset{O}{\overset{\|}{C}}$	138.2	215.2	205†	....	0.3	7.68
Diisobutyl Ketone	$(CH_3)_2CHCH_2\overset{O}{\overset{\|}{C}}CH_2CH(CH_3)_2$	142.2	168.1	140†	....	1.7	6.72
Methyl Ethyl Ketone	$CH_3CH_2\overset{O}{\overset{\|}{C}}CH_3$	72.1	79.6	34°	28°	71.2	6.71
Diethyl Ketone	$CH_3CH_2\overset{O}{\overset{\|}{C}}CH_2CH_3$	86.1	102.0	55†	....	....	6.79
Ethyl Butyl Ketone	$C_4H_9\overset{O}{\overset{\|}{C}}CH_2CH_3$	114.2	147.3	115†	....	3.9	6.82

* Tag. † Cleveland.

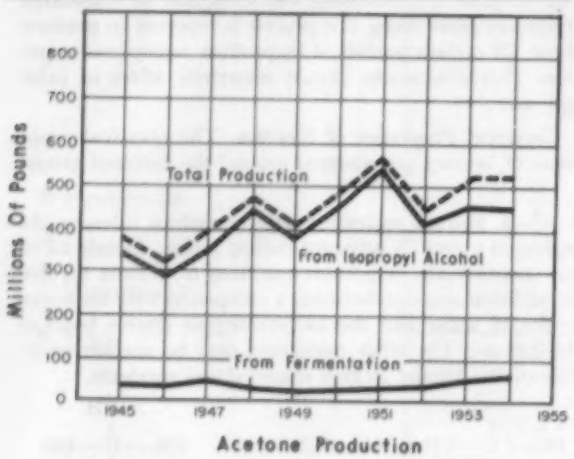
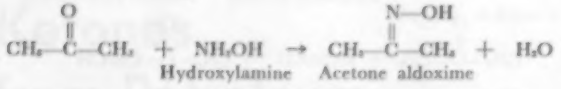
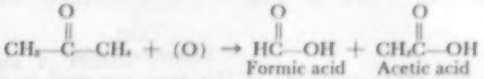


Figure 3. Acetone production by years since 1945.



Ketones can be oxidized using fairly severe conditions to give a mixture of acids containing less carbon atoms than the original ketone.



None of these reactions is of special industrial importance.

Ketones as solvents. The solvent properties and uses of ketones shouldn't be passed over lightly. For the most part ketones are pleasant smelling, water-white liquids. They are outstanding solvents for nitro-cellulose, vinyl chloride-acetate resins and for many other natural and synthetic resins. The plastics, rayon, photographic film, artificial leather and protective coating industries use large quantities of ketones. Other solvent applications of ketones include the dewaxing of lubricating oils, the extraction of pharmaceuticals, the stripping of dyestuffs from fabrics, and the coagulation of rubber latices.

Acetone

Acetone is the most important ketone, with its production in 1954 of over 500 million pounds (Figure 3) being two and one half times that of its nearest rival (methyl ethyl ketone). Any compound which is produced in this quantity is likely to have several methods of production and a number of important uses. This is especially true with acetone.

Methods of Production. There are four industrial processes used for the production of acetone. Three of them are petrochemical in origin while the fourth is a fermentation process. This latter source accounts for about 10 percent of the yearly production and will not be further noted because it has no direct relationship to petroleum.

The three petrochemical processes are: (1) the oxidation-dehydogenation of isopropyl alcohol; (2) oxidation of propane and butane and (3) oxidation of cumene. The first process accounts for the bulk of acetone production. In the other two the acetone is a by-product.

Oxidation-Dehydrogenation of Isopropyl Alcohol. The oxidation of isopropyl alcohol to acetone is an exothermal reaction.

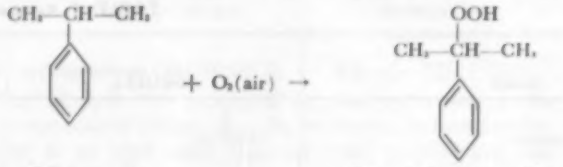
The dehydrogenation of isopropyl alcohol to acetone is an endothermal reaction.

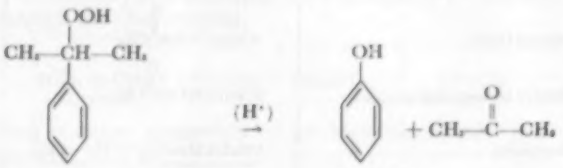
Both of these reactions may be catalyzed by the same type of catalyst (copper, zinc oxide). The oxidation reaction gives a somewhat lower yield (75-85 percent) and presents problems of temperature control.

In the oxidation process, air saturated with isopropyl alcohol vapors is passed over a copper catalyst maintained between 400-600 C. The hot gases are partially cooled and scrubbed with water. The acetone is recovered from the water by conventional methods. The dehydrogenation process operates over a brass or copper catalyst at 500 C. and 40 to 50 psi. It is reported that a combined oxidation-dehydrogenation process is also used. In this type of operation oxidation of part of the isopropyl alcohol provides the heat for the dehydrogenation of the rest of the isopropyl alcohol.

Oxidation of Cumene. The oxidation of cumene to produce phenol and acetone is a very recent development with the first plant in the United States (Standard of California, Richmond, Calif.,) announced on stream March, 1954. The process is primarily carried out for the production of phenol (Figure 2), but the concomitant production of acetone can become a major factor in the acetone picture as more and more phenol is made by this process.

Two separate steps are involved in the oxidation of cumene to phenol and acetone. The first is autooxidation of the cumene to cumene hydroperoxide followed by acid cleavage of the hydroperoxide to the desired products.





The cumene is air oxidized between 85-130 C. with a conversion of 25-40 percent. The hydroperoxide is decomposed (cleaved) by dilute sulfuric acid. An 80 percent yield is realized.

Partial Oxidation of Paraffin Hydrocarbons. The relatively high pressure, low temperature, catalytic air oxidation of butane by Celanese yields acetic acid as the major product along with the following primary prod-

ucts: acetone, methyl ethyl ketone, acetaldehyde, methanol, formic acid, propionic acid, butyric acid, and various lactones. Non-catalytic oxidation gives acetaldehyde as the major product and an appreciable amount of formaldehyde.

Oxidation of propane in the presence of hydrogen bromine at 189 C. gives a high yield (75 percent) of acetone. The process is costly, however, because of the loss (13-17 percent) of hydrogen bromide.

Uses. Traditionally, acetone is considered a solvent with other uses of only secondary importance. While this may be true for most other ketones, it is no longer valid for acetone; it is estimated that 60 to 65 percent of the current acetone production is used as raw material for other compounds.

Diacetone alcohol [4-hydroxy-4-methyl-2-pentanone, $(CH_3)_2COHCH_2\overset{O}{\overset{\|}{C}}CH_3$] is the derivative of acetone produced in the largest amount. It is formed by the condensation of two molecules of acetone in the liquid phase over a fixed bed alkali catalyst at 0-20 C.

$$CH_3-\overset{O}{\overset{\|}{C}}-CH_3 + CH_3-\overset{O}{\overset{\|}{C}}-CH_3 \rightarrow CH_3-\underset{CH_3}{\overset{OH}{\overset{|}{C}}}-CH_2-\overset{O}{\overset{\|}{C}}-CH_3$$

Diacetone alcohol has the dual role of solvent and precursor of other ketones. It is a good solvent for vinyl chloride-acetate resins and epoxide resins as well as for cellulose acetate and nitrocellulose. It is also used as a solvent for pentachlorophenol, a wood preservative, and as a component of many commercial brake fluids. Its use in brake fluid is small compared with that of the glycol ethers.

Mesityl oxide [$(CH_3)_2C{=}CHC\overset{O}{\overset{\|}{C}}CH_3$] is made by the dehydration of diacetone alcohol at 100-120 C. in the presence of a weak acid.

$$CH_3-\underset{CH_3}{\overset{OH}{\overset{|}{C}}}-CH_2-\overset{O}{\overset{\|}{C}}-CH_3 \rightarrow CH_3-\overset{CH_3}{\overset{|}{C}}=CH-\overset{O}{\overset{\|}{C}}-CH_3 + H_2O$$

Mesityl oxide is a medium-boiling solvent used to slow down evaporation of surface-coating solvents and to promote good flowing properties. About 90 percent of the solvent mesityl oxide is consumed in the preparation of nitrocellulose and vinyl lacquers and thinners. Mesityl oxide is both an olefin and a ketone; thus it is amenable to a wide variety of reactions.

Methyl isobutyl ketone, MIBK, [4-methyl-2-pentanone $(CH_3)_2CHCH_2\overset{O}{\overset{\|}{C}}CH_3$] is the most important derivative of mesityl oxide. It is formed by mild hydrogenation.

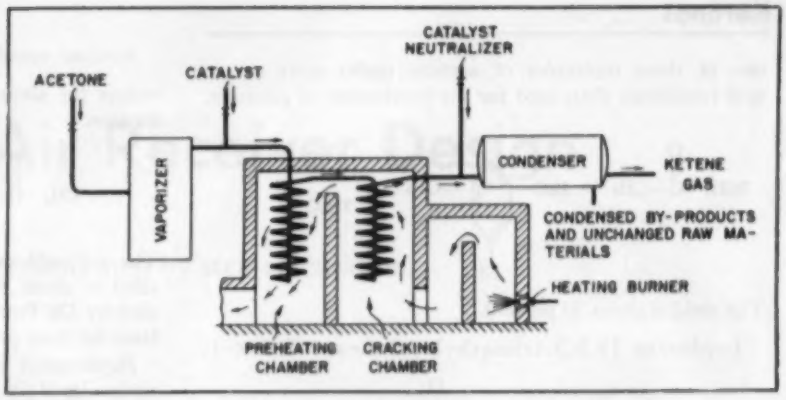


Figure 4. Production of ketene by the pyrolysis of acetone.

$$CH_3-\overset{CH_3}{\overset{|}{C}}=CH-\overset{O}{\overset{\|}{C}}-CH_3 + H_2 \rightarrow CH_3-\overset{CH_3}{\overset{|}{C}}H-CH_2-\overset{O}{\overset{\|}{C}}-CH_3$$

MIBK is the major medium-boiling ketone, and its main uses are similar to those of mesityl oxide. About 120 million pounds are produced annually. Further hydrogenation gives *methyl isobutyl carbinol* [$(CH_3)_2CHCH_2CHOHCH_3$] which is a good solvent and which is also used as an intermediate in the production of xanthates and esters.

Phorone [$(CH_3)_2C{=}CH-\overset{O}{\overset{\|}{C}}-CH{=}C(CH_3)_2$] may be considered as being formed by the reaction between mesityl oxide and a molecule of acetone.

$$CH_3-\overset{CH_3}{\overset{|}{C}}=CH-\overset{O}{\overset{\|}{C}}-CH_3 + CH_3-\overset{O}{\overset{\|}{C}}-CH_3 \rightarrow$$

$$CH_3-\overset{CH_3}{\overset{|}{C}}=CH-\overset{O}{\overset{\|}{C}}-CH=\overset{CH_3}{\overset{|}{C}}-CH_3 + H_2O$$

This reaction takes place under acid conditions. Mild hydrogenation yields *diisobutyl ketone DIBK*

$[(CH_3)_2\text{-}CHCH_2\overset{O}{\overset{\|}{C}}CH_2CH(CH_3)_2]$

which is a high-boiling solvent.

Mesitylene [$C_6H_3(CH_3)_3$] is formed by the condensa-

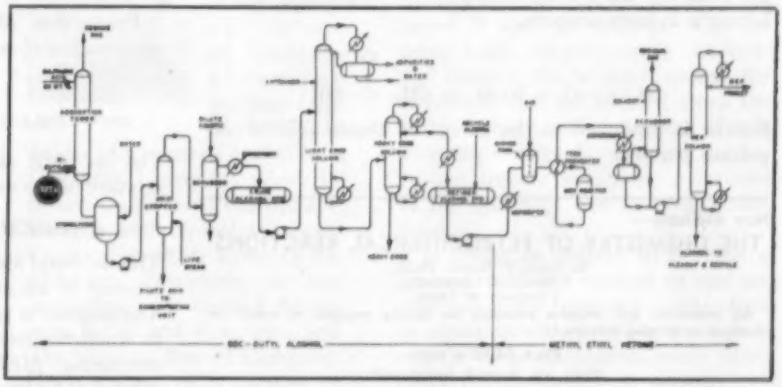
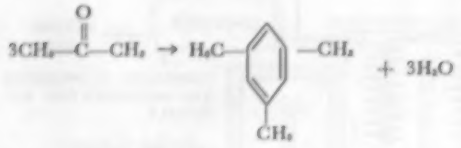


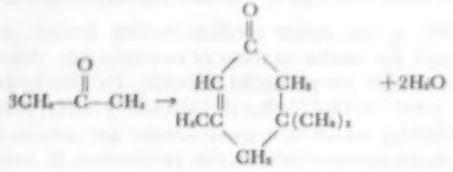
Figure 5. Production of methyl ethyl ketone (MEK) by the oxidation-dehydrogenation of sec-butyl alcohol.

tion of three molecules of acetone under more severe acid conditions than used for the production of phorone.



The yield is about 30 percent.

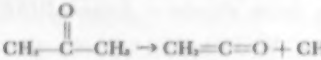
Isophorone [3,5,5-trimethylcyclohexen-2-one-1, $CH_2C(CH_3)_2CH_2C(CH_3)=CHC(=O)$] is a cyclic derivative formed by the condensation of three molecules of acetone.



The reaction may be carried out either in the liquid phase at 140-170 C. under pressure or in the vapor phase at 350 C. Basic catalysts are used and a wide variety of products is obtained.

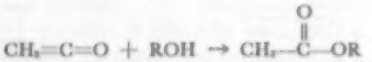
Isophorone is a high-boiling solvent used to prolong the drying period of lacquer finishes. The purpose is to leave a glossy finish, increase blush resistance, and keep droplets of sprayed coatings in solution. Diacetone alcohol, diisobutyl ketone and cyclohexanone are also used for these purposes. Isophorone is an exceptionally powerful solvent for vinyl chloride-acetate resins.

Ketene ($CH_2=C=O$) is formed by the cracking of acetone (Figure 4) at 700-850 C.



Various catalysts may be used and the yields are relatively high.

Ketene is used in the production of acetic anhydride, but at the present time other methods are of more importance in this country. The other important use of ketene is to form acetates.



Ketene is produced to the extent of about 125 million pounds per year.

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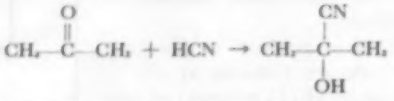
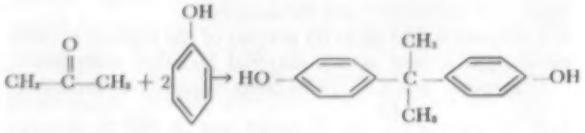
Acetone cyanhydrin (CH_3COHCH_3) synthesis accounts for about 6 percent of the annual acetone production.



The addition takes place below 25 C. and an over all yield of about 90 percent is obtained. The cyanhydrin is used by Du Pont and Rohm & Haas to make methacrylates for resin production.

Bisphenol-A is produced by the condensation of two molecules of phenol with one of acetone.



The reaction is carried out at room temperature in the presence of strong acids as catalysts. The yields are 80-90 percent. Bisphenol-A is polymerized with epichlorohydrin to form epoxide resins. This use of acetone will grow with the expanding use of resins of this type.

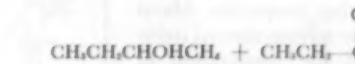
There are a number of lesser chemical uses of acetone but space will not permit a discussion of them. Additional information on acetone and ketene has been recently published. (See "Acetone—Its Production and Uses," PETROLEUM REFINER, December, 1954 and "Valuable Intermediate: Ketene," PETROLEUM REFINER, August, 1954).

Methyl Ethyl Ketone

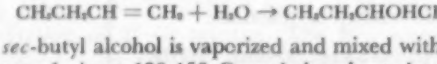
Methyl ethyl ketone, *MEK*, is the younger brother of acetone with an annual production estimated at 200 million pounds. Its method of production and its utilization follow closely those of acetone except in the area of synthesis.

Nitrocellulose, vinyl, cellulose acetate butyrate, and acrylic surface coatings use 65-70 percent of *MEK* production. It is also used as a solvent for synthetic and natural resins for cellulose nitrate lacquers. The balance of the *MEK* is used in paint, lacquer and varnish removers, synthetic rubber adhesives, and industrial cleaning compounds.

Production. *MEK* is produced by the oxidation-dehydrogenation of *sec*-butyl alcohol



The *sec*-butyl alcohol is obtained by the hydration of a mixture of the normal butylenes (Figure 5).



The *sec*-butyl alcohol is vaporized and mixed with a small amount of air at 120-150 C. and then heated to 400 C. The mixture is passed over a supported zinc oxide catalyst in small-diameter tubes at not over 535 C. The effluent containing *MEK*, unconverted alcohol, hydrogen and other fixed gases is worked up in a conventional manner. The yield based on the butylene is 75-80 percent.

Short Cut to Air Receiver Design

. . . and no more tedious step by step calculation.

J. T. Fong,
Foster Wheeler Corporation,
New York

OF ALL THE auxiliary services in a modern petroleum refinery, a steam plant, or a chemical plant, the compressed air system plays a significant role in the operation of the plant. This is unquestionably so when the instrumentation of the whole plant utilizes a pneumatic system for control purposes. The instrument air compressors and instrument air receivers therefore are standard equipment in a plant. In addition to the instrument air service, high pressure compressed air has been utilized for blowing soot off boiler tubes in most high pressure steam generators. A third use of compressed air service in a plant would be for the general service. Hence, compressed air stands high on its own merits in the list of auxiliary services of any modern plant.

The functions of an air receiver are usually dual fold. It acts as a surge tank. It also acts as a reservoir for a continuous air supply for a designed duration when a compressor fails, or, for economic reasons, as in the case of intermittent soot-blowing service when the compressors are too costly to be sized to meet the maximum demand. In the latter case, the receiver serves as a supplementary source of air supply. For example, in the soot-blowing air requirements for a one-million pounds-per-hour steam cyclone furnace boiler, the maximum demand at the nozzle of some soot-blowers may be as high as 4200 cfm of standard air supplied at 300 psig for a duration of 6.84 minutes. However, the average air demand in a complete cycle of air blowing may not even approach half of the maximum air demand, and since the prices of air compressors in those capacities become prohibitive, it is obvious that an air receiver properly sized becomes extremely worthwhile. Thus, after careful analysis, one may recommend that the soot-blower air compressors in such an installation should be sized for a design capacity of 2000 cfm standard air with 500 psig compressor discharge, while the receiver should be sized to yield 2200 cfm standard air by expanding 500 psig air to 300 psig air for 6.84 minutes. The maximum demand of 4200 cfm at 300 psig for a duration of 6.84 minutes is therefore met.

The largest air receivers by far used in the industry and designed for considerably higher pressures, may be found in the various supersonic wind tunnels designed to simulate altitudes and to create equivalent aircraft speeds during the brief test interval. Such testing facilities involve the compressing and storing of large quantity of air in the receiver, and finally, releasing this compressed air through the test section of the wind tunnel to achieve the test conditions of speed and altitude desired for a few seconds. The sizing of such a receiver, or pressure vessel, is identical to the applications mentioned in the previous paragraphs, and the same method of analysis developed in this article applies.

In the case of the instrument air service, the consideration revolves around the optimum duration which control air should be available at adequate pressure after complete failure of air compressing sources. It has been found practical that the instrument air system not "backed up" by general service air or other independent sources of compressed air should have a receiver storage capacity between 5 and 10 minutes. On the other hand, for adequately "backed-up" systems, the ASME Standard Air Receivers may be selected from the Table recommended by the Trade Standards of the Compressed Air Institute, mainly to absorb pulsations in the discharge line from the compressor.

It would be helpful to develop a general short-cut method to size air receivers in the form of a simple chart or equation without going through a step by step calculation every time. Since the maximum air pressure required for the satisfactory operation

Meet the Author

JAMES T. FONG, born in Shanghai in 1927, already has a background of several years experience in project engineering for the U. S. refining industry. A mechanical engineering graduate from M. I. T. and holder of a master's degree from Columbia University, where he is now a doctoral candidate, Fong is with Foster Wheeler Corporation in its Research department. Previously, he was connected with Bechtel Associates, Burns and Roe, Inc., and The Griscom-Russell Company. He is author of a number of published articles.

Fong

"The functions of an air receiver are usually dual fold. It acts as a surge tank. It also acts as a reservoir for a continuous air supply for a designed duration when a compressor fails, or for economic reasons, as in the case of intermittent soot-blowing service when the compressors are too costly to be sized to meet the maximum demand. In the latter case, the receiver serves as a supplementary source of air supply. For example, in the soot-blowing air requirements for a one-million pounds-per-hour steam cyclone furnace boiler, the maximum demand at the nozzle of some soot-blowers may be as high as 4200 cfm of standard air supplied at 300 psig for a duration of 6.84 minutes."

of any of the penumatic instruments, controllers, and positioning devices is 40 psig in a Bailey system and 60 psig in a Hagan system, the chart developed is based on an initial receiver pressure of 100 psig which corresponds to the discharge pressure of most standard air compressors. Furthermore, the capacities of ASME Standard Air Receivers are also shown on the abscissa so that a ready selection may be made when the storage duration is determined. Otherwise, the chart is self-explanatory. It is assumed that the compressed air is cooled to 100 F in the aftercooler. The example in the chart illustrates an actual case when the demand of 120 cfm free air at 40 psig for 10 minutes requires a receiver capacity of 400 cubic feet.

In the general case, as shown by the application of the soot-blowing air service, with the air receiver of volume V cu ft initially at pressure P_1 psia and temperature T_1°R, and a net load demand of V_s cfm measured at standard pressure P_s psia and T_s°R, air in the receiver expands from P_1 to P_2 in time t minutes to meet the demand required. The receiver volume V may be found by the straight line relationship of:

$$V = m\,V_s$$

where m is the slope of the line and equals

$$\left(\frac{P_s/P_1}{1-(P_2/P_1)^{1/k}}\right)\left(\frac{T_1}{T_s}\right)(t)$$

with k being the ratio of specific heats of air.

Illustrative Problem:

In the soot-blowing example cited earlier,

Demand $V_s = 4200 - 2000 = 2200$ cfm
Standard Air $P_s = 14.7$ psia
Standard Air $T_s = 460 + 68 = 528$°R
Final Receiver Pressure $P_2 = 314.7$ psia
Assume T_1 = Standard Air Temp. T_s for this example.
Initial Receiver Pressure $P_1 = 514.7$ psia
Duration $t = 6.84$ minutes
$k = 1.4$

$$V = \frac{14.7/514.7}{1-(314.7/514.7)^{1/1.4}} \times 6.84 \times 2200$$

$$= 1450 \text{ cu. ft.}$$

It is important to note that standard air refers to air at temperature of 68F, a pressure of 14.7 psia and a relative humidity of 36 percent (.0750 density.) This definition has been adopted by the ASME.

Derivation of Equation (A):

Given: A load demand of V_s cfm air measured at standard conditions.

To Find: Receiver capacity that will supply this load demand for t minutes.

Nomenclature: Refer to the main body of the article.

Assume ideal gas, $PV = RT$ (1)

Assume irreversible isentropic expansion: $PV^k = \text{constant}$ (2)

After expansion:

$$T_2 = T_1\,(P_2/P_1)^{(k-1)/k} \quad (3)$$

Volume of air at P_2, i.e., the load demand at $P_2 = (P_s/P_2)\,(T_2/T_s)\,tV_s$ (4)

Total volume at P_2 after expansion

$$= V + (P_s/P_2)\,(T_2/T_s)\,tV_s \quad (5)$$

In expanding V to V_2,

$$V_2 = V\,(P_1/P_2)^{1/k} \quad (6)$$

Substituting (3) into (5) and equate (5) and (6), we have

$$V = \left(\frac{P_s/P_1}{1-(P_2/P_1)^{1/k}}\right)\left(\frac{T_1}{T_s}\right)(t)\,V_s \quad (A)$$

The chart developed applies to air under the low pressure conditions indicated. For high pressure applications, it is apparent that compressibility of gases becomes important and Equation (1) should then be modified to this form:

$PV = ZRT$ where Z is the compressibility factor.

Chart Opposite ⟶

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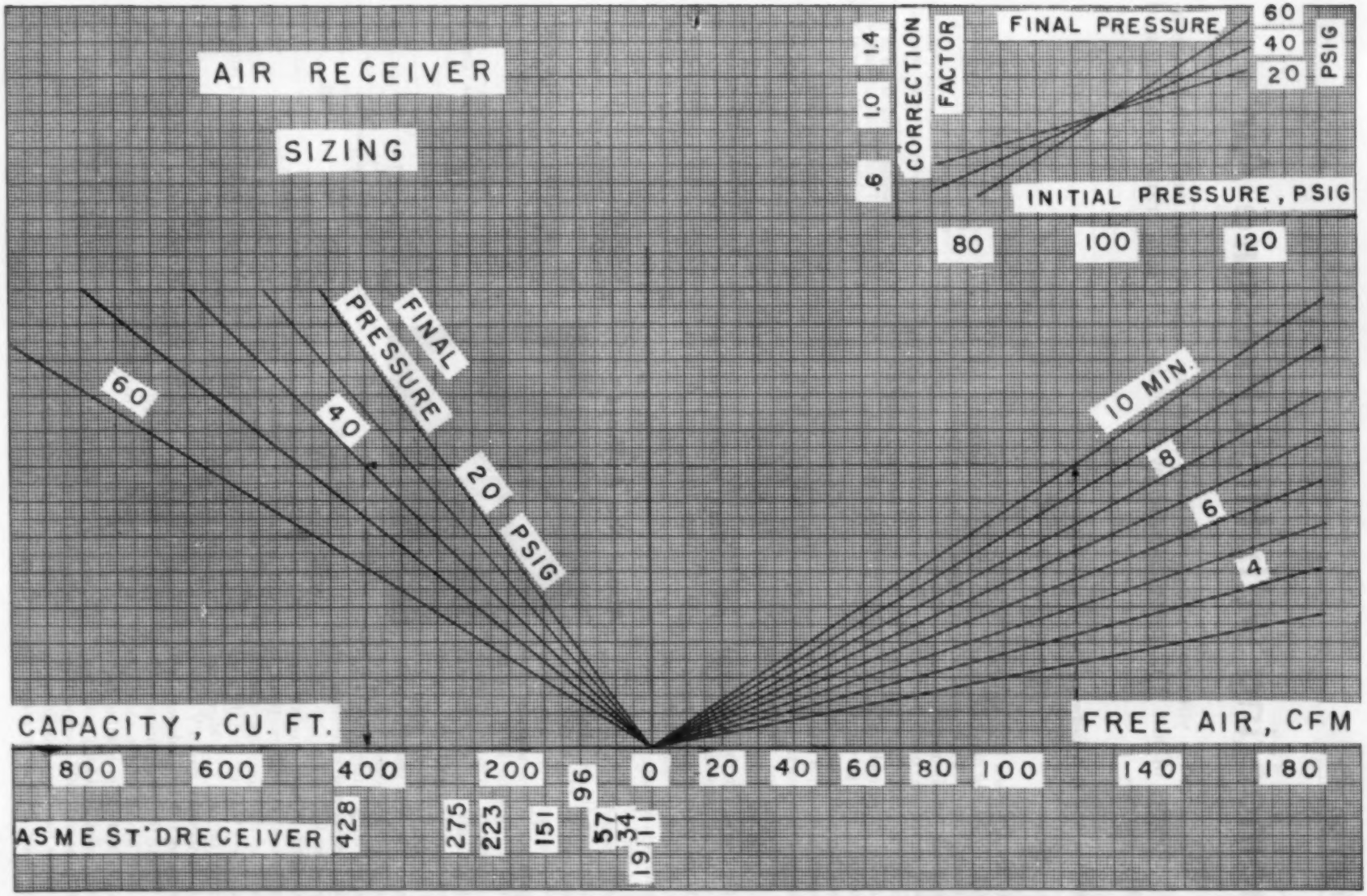


NOTE: The chart (see text on preceding two pages) is based on an initial receiver pressure at 100 psig. For other initial pressures, divide the receiver capacity obtained by the correction factor.

Engineering with High-Pressure Air

Here is your convenient working chart for high-pressure and high-temperature properties of air. This pressure-enthalpy chart includes temperature, volume and entropy curves.

J. E. Wilson and E. E. Ludwig,
The Dow Chemical Company,
Freeport, Texas

AIR, AS A process tool and raw material, is becoming more and more in demand. For most operations atmospheric air or air not exceeding 200 psig serves the purpose well. Within recent years there has been an increase in petrochemical processes utilizing high pressures. These processes have often required air as a necessary part. Air is often used for dilution of other reactants, as mild source of oxygen, and for numerous other complex operations.

A recent need for thermodynamic data for air at pressures in the 1500 to 2500 psi pressure range revealed the distinct lack of such information. Information in suitable form for engineering use was not directly found, but the necessary data were presented by Gerhart, et al.[1] in tabular form. This was not readily usable for repetitive "trial and error" calculations.

Preparation—By a series of cross plots the information in the article was transformed into a "Pressure-Enthalpy Chart For Air." Specific volumes were included for convenience. By the use of the chart such calculations as heat loads on coolers, volume of storage vessels and air receivers, and temperature changes during compression and expansion can readily be made.

Application—Other engineering data of considerable importance to engineers in high pressure calculations are the PV factor and the compressibility factor (Z). Most engineering handbooks give PV factors for air up to 100 atmospheres (1470 psia). From the information in the article and by use of the chart, the PV factors and compressibility factor have been calculated for pressures up to 3000 psia and 550F. temperature. These values have been plotted on the accompanying PV-Factor graph. It is interesting to note from the graph that intermediate pressures can be interpolated with a very small percentage of error.

The compressibility factors and PV factors were calculated using the following relationships[2]:

A. *Specific Volume of Air:*

$$\overline{V}_2 = \frac{359}{28.99} \times \frac{14.7}{P_2} \times \frac{T_2}{491.7} \times Z_2$$

B. *(PV)-Z Relationship:* Referenced to 0°C. (32F.)

The relationship between (PV) factors (Amagat units) and Z (compressibility) factors may be defined briefly:

Z-Factors

$PV = ZNRT$

Where:

Z = Compressibility factor and is equal to 1.00 for perfect gases at any pressures and also equal to 1.00 for any gas at zero pressure.

R = Gas constant.

N = Mols or pounds of gas, consistent with units of R.

(PV) Factors

$$Z_2 = Z_o\,(PV)_2\,\frac{491.7}{T_2}$$

Z_o = Essentially Unity = 1.00

$$Z_2 = (PV)_2\,\frac{491.7}{T_2} \qquad \text{Then:}$$

$$(PV)_2 = Z_2\,\frac{T_2}{491.7}$$

For clarity, is offered:

Amagat's definition: At 1 Atm. and 0°C.

$$(PV)_{(0^\circ\text{-}1\ \text{Atm})} = 1.000$$

By definition of Z:

$$Z_{(0^\circ\ \text{Atm})} = 1.000$$

Substituting: Perry[3,4] lists value of:

$$\frac{(PV)_{(0^\circ\text{-}0\ \text{Atm})}}{(PV)_{(0^\circ\text{-}1\ \text{Atm})}} = 1.0006$$

Then:

$$Z_{(0^\circ\text{-}1\ \text{Atm})} = \frac{(PV)_{(0^\circ\text{-}1\ \text{Atm})}}{(PV)_{(0^\circ\text{-}0\ \text{Atm})}} = \frac{1.00}{1.0006} = Z_o$$

SYMBOLS

$\overline{V}_2$ = Specific volume of air at pressure P_2 and temperature T_2.
P_2 = Pressure, psia.
T_2 = Temperature °F. absolute (°R).
Z = Compressibility factor as previously defined.
Z_o = Compressibility factor of gas at 0°C (32F.) and 1 atm. pressure.
Z_2 = Compressibility factor of gas at any condition, No. (2).

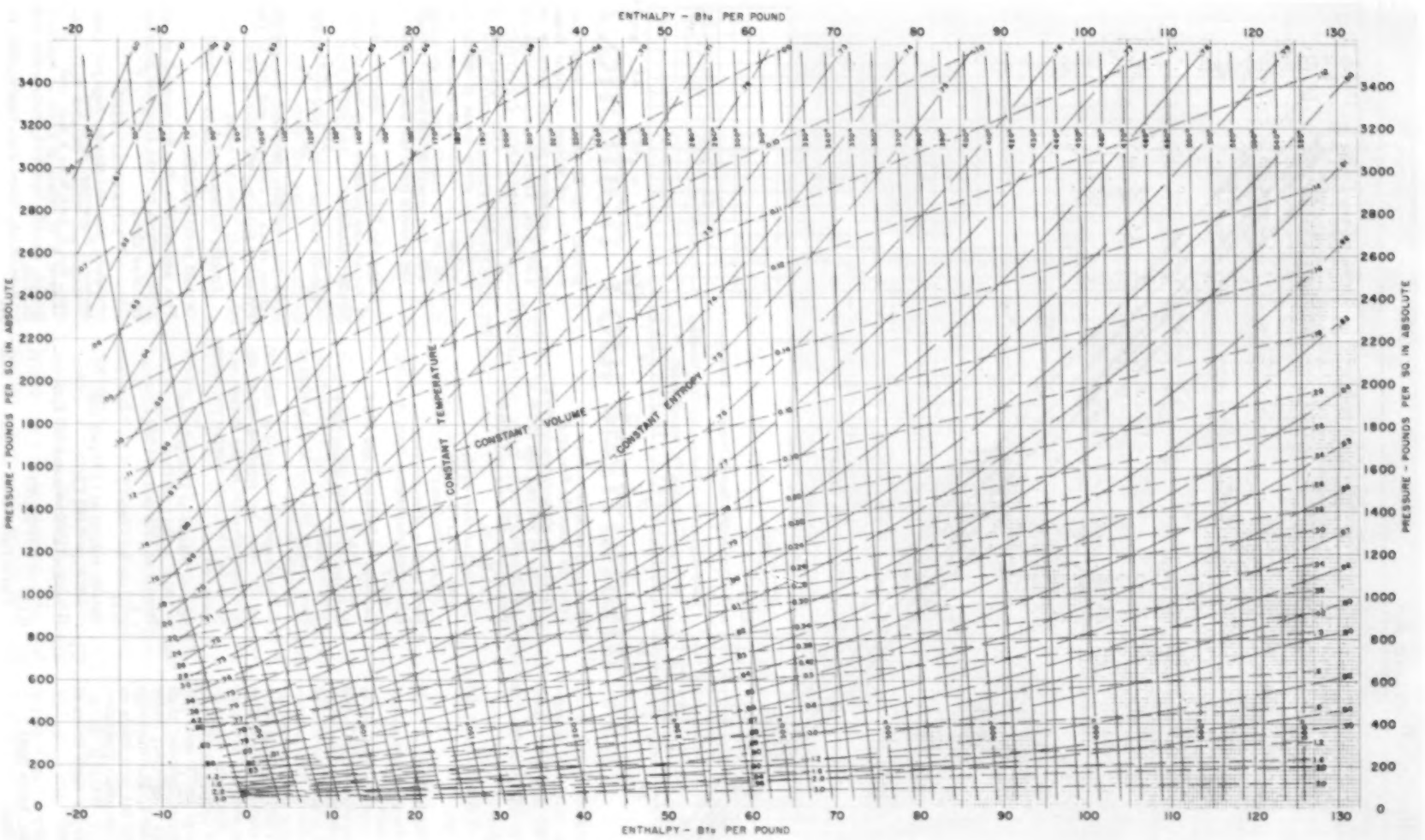
SUBSCRIPTS

No. 2 = any condition other than reference or "S."
0° = 0°C
1 Atm = one atmosphere pressure
S = conditions at 0° and 1 atm. pressure

About the Authors

Wilson Ludwig

J. E. WILSON and E. E. LUDWIG, both with The Dow Chemical Company in Freeport, first met at the University of Texas where they were students in 1933. Wilson, senior design engineer, has been with Dow for 11 years. Ludwig, who is process design manager, joined the company in 1942. Registered both as a chemical and mechanical engineer, he previously had charge of Dow's engineering office in Houston and served as assistant engineering manager at Freeport.



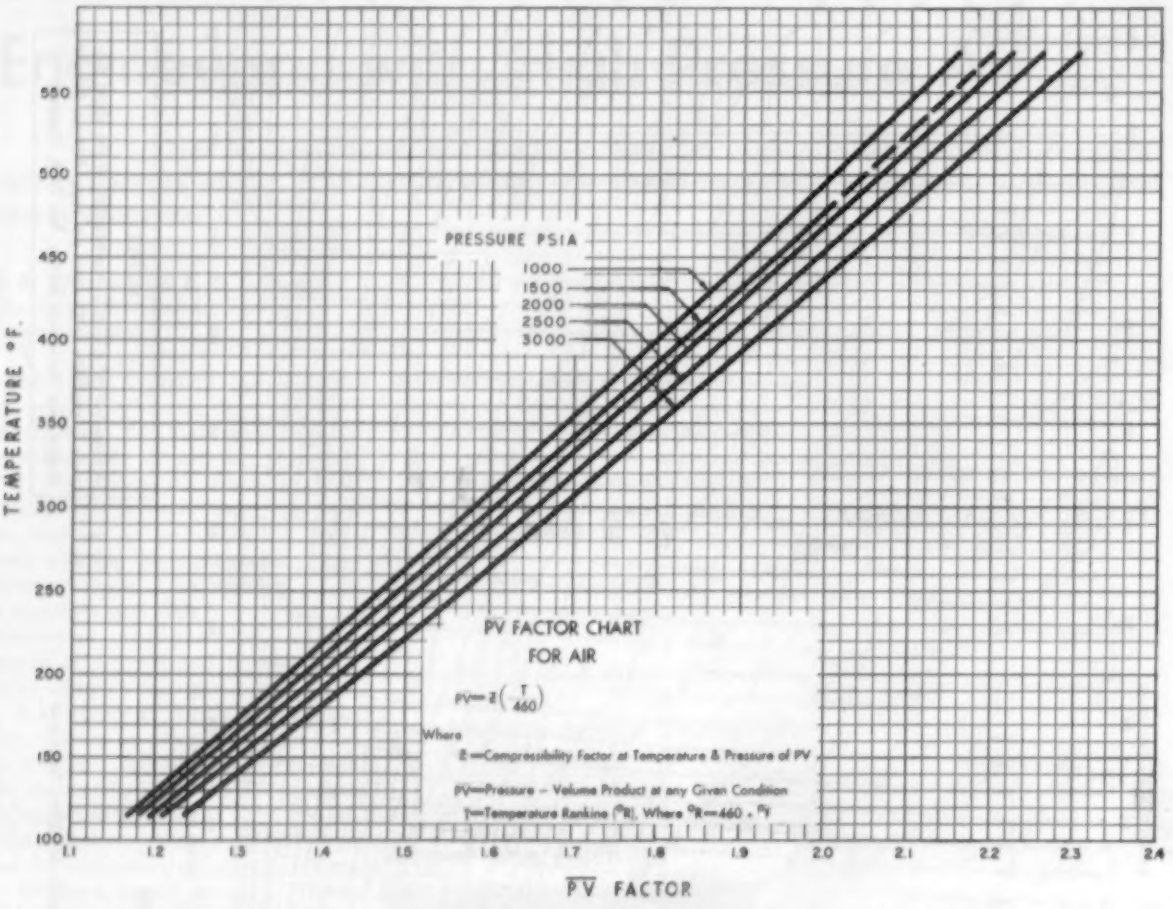
PRESSURE-ENTHALPY DIAGRAM FOR AIR

Legend: Temperature in degrees Fahrenheit
Entropy in Btu per pound per degree Fahrenheit
Specific Volume in cubic feet per pound

(Data Source: "Thermodynamic Properties of Air" by Gerhart, Brunner, Mickley, Sage and Lacey, published in Mechanical Engineering, April, 1942)

NOTICE

A large (17½" x 11½") reproduction of the above diagram is available at 25 cents per copy. Address Reprint Department, Petroleum Refiner, Box 2608, Houston.



Although it is recognized that these relationships are in error by assuming $Z_o = 1.0$ at 0°C and 14.7 psia, for most engineering calculations this effect will be negligible.

Therefore Z(0°—1 Atm) may be taken as unity for air.

SAMPLE PROBLEM

Let us assume a problem to demonstrate the versatility of the chart:

It is necessary to compress dry air in two stages to 2500 psia, cool to 300 F. and store for continuous process use. The process demand is for 500 pounds per hour of air at 1200 psia and 300 F. The pressure switch on the compressor shall operate between the limits of 1500 psia and 2500 psia. The compressor shall be of sufficient capacity to operate for one hour for every eight-hour shift. The first stage compression cylinder shall take suction at 100 psia and 100 F. and discharge at 500 psia. The second stage compression cylinder shall take suction at 500 psia (neglecting cooler pressure drop) and 100 F. and discharge at 2500 psia. What are the heat loads on the inter-cooler and after-cooler (assuming adiabatic compression)? What is the required storage capacity for eight hours of process operating time?

1. Compressor capacity
   = 8 × 500 lbs./hours (use)
   = 4000 lbs./hour
2. Heat load on inter-cooler:
   From the chart the first stage discharge temperature is 390 F.
   Enthalpy at 500 psia and 390 F. = 86 Btu/lb.
   Enthalpy at 500 psia and 100 F = 13.1 Btu/lb.
   Heat load on inter-cooler (86 — 13.1) × 4000 = 291,600 Btu/hour.
3. Heat load on after-cooler:
   Discharge temperature from chart = 428 F.
   Enthalpy at 2500 psia and 428 F. = 93.5 Btu/lb.
   Enthalpy at 2500 psia and 300 F. = 59.3 Btu/lb.
   Heat load = (93.5 — 59.3) × 4000 = 136,800 Btu/lb.
4. Storage capacity required so that 500 lbs./hr. can be removed with the minimum pressure in the storage vessel to be 1500 psia after seven hours operation.

   Specific volume at 2500 psia and 300 F. = 0.12 Cf/lb.
   Density at 2500 psia and 300 F. = $\frac{1}{0.12}$ = 8.33 lbs./Cf
   Specific volume at 1500 psia and 300 F. = 0.191 Cf/lb.
   Density at 1500 psia and 300 F. = $\frac{1}{0.191}$ = 5.24 lbs./Cf
   Therefore 8.33 — 5.24 = 3.09 pounds can be removed from each cubic foot of storage in eight hours for a minimum storage pressure of 1500 psia. Then the storage required $= \frac{500 \times 7}{3.09} = 1132$ cubic feet of storage for seven hours of operation without the compressor running. The air for the eighth hour of operation will, for practical purposes, be coming directly from the compressor.

Using the PV factor the specific volume of air at any pressure may be calculated by the relation:

$$\text{Specific volume} = \frac{359}{28.99} \times \frac{14.7}{P_2} \times PV$$

As an example, calculate the specific volume of air at 2500 psia and 300 F. The PV factor from the PV curve is 1.65.

$$\text{Specific volume} = \frac{359}{28.99} \times \frac{14.7}{2500} \times 1.65 = 0.120 \text{ Cf/lb.}$$

This agrees with the figure used in the problem above as read from the pressure-enthalpy chart.

LITERATURE CITED

[1] Gerhart, Brunner, Mickley, Sage and Lacey, *Mechanical Engineering*, April, 1942.
[2] Hougen and Watson, *Chemical Process Principles*, Part 2, John Wiley & Sons, 1948.
[3] Perry, J. H., *Chemical Engineers' Handbook*, 3rd Ed., Pg. 205, New York, McGraw-Hill Book Co., 1950.
[4] Kobe, K. A., *Chem. Eng.*, October, 1951, Pg. 143.

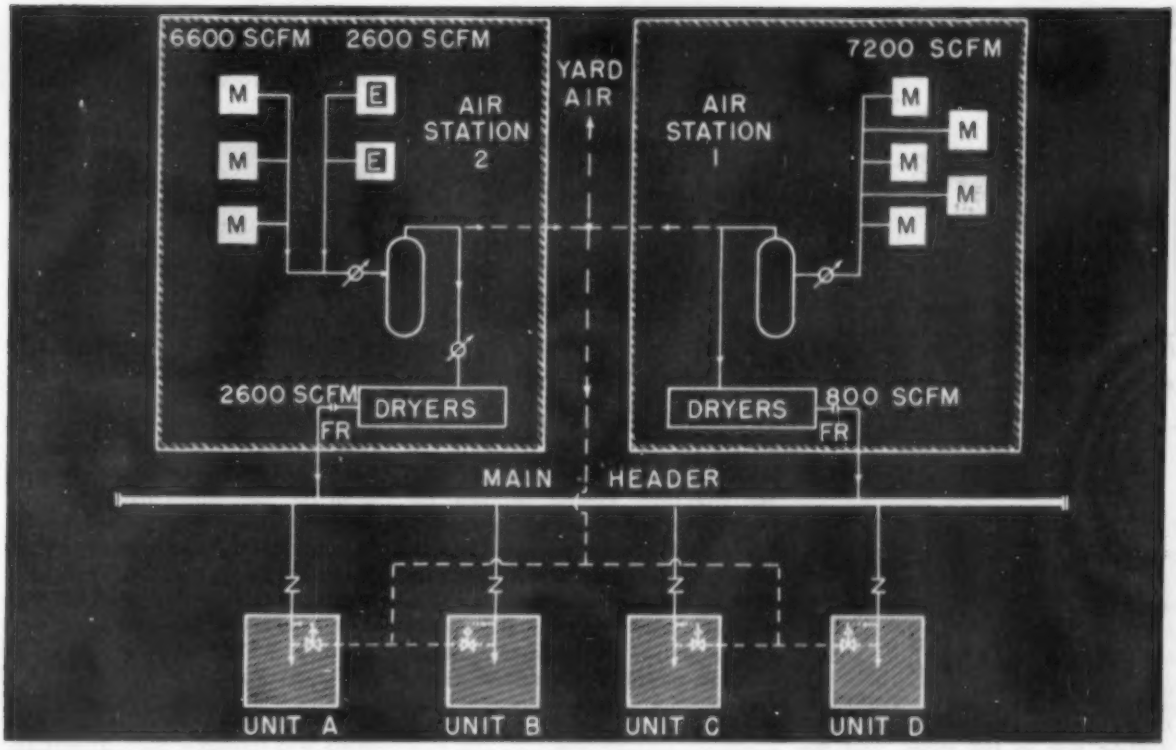


Figure 1. Schematic flow diagram of central instrument air system.

Designs on Air

Condition Your Instrument Air

Avoidance of process interruptions during severe weather, in addition to improved instrument performance and lower maintenance, among the advantages of using conditioned instrument air.

R. L. Dockendorff
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INDUSTRIAL INSTRUMENTS operate better and cost less to maintain when they are supplied with air of good quality. Suppliers have been emphasizing this for years; users and maintainers have agreed; process designers have learned to provide a clean air supp! for all new, instrumented process units. The only remaining variations between plants concern the cleanliness, dryness, quantity, preparation, and degree of system centralization desirable for each user.

The literature contains several treatments of design of instrument air systems in general[1] and of gas dryers in particular. The arguments in favor of conditioned air for pneumatic instruments have been presented several times. This discussion is intended principally to provide case history information on the development of dry instrument air at Humble Oil & Refining Company's Baytown refinery, where the facilities are extensive and varied, and where lessons have been learned that may be of benefit to other operators.

All-electronic instrumentation is moving closer with a full-plant installation recently announced, and with limited applications among many of the large instrument users. The swing to full electronic certainly will not come until available equipment has been fully tested and maintenance crews acquire the necessary skills. Electrically-driven control valves probably are still further away. In any event, until air is no longer required for any of the components of a control system, operators will be faced with air-supply problems.

Although the practice of instrument air conditioning is quite general, the use of a central system as at Baytown is much less common; for this reason it should be of interest. The central

Dry Instrument System . . .

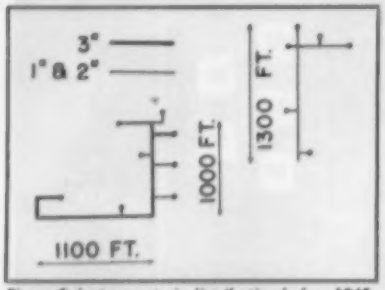

Figure 2. Instrument air distribution before 1948.

system may be a money-saver

(1) if it is possible to avoid depending on a single source of supply,
(2) if it is possible to prevent or control the misuse of conditioned air for non-instrument use,
(3) if process facilities are being expanded, and
(4) if there are several process units fairly closely spaced which use appreciable amounts of air.

The Baytown central system became possible when the post-war expansion was in full swing, and the existing air supply system was far from ideal. Even today there is considerable incentive to expand it further to include a group of process units that, with refinery growth, are no longer as remote as they were in 1948.

The Baytown System

Justification—Prior to the completion of a central instrument-air system in 1948, Baytown's facilities varied from area to area, but in no place were really satisfactory and in most places were a source of frequent trouble. Seven small-capacity compressors were scattered about the refinery, some serving a single unit and some manifolded to supply a group of units in a high-use area. All were spared by a connection into the industrial-air system. Some of these units had high oil carryover; most of them were old and required frequent maintenance. Both electric motor and steam drivers were used. Aftercoolers and condensate knock-out vessels were provided in all cases, and some were followed by activated bauxite, calcium chloride, or kerosine dryers. Some of the yard-air cut-ins were on pressure control; some were not. Distribution was by black-iron-pipe headers which in some cases were quite long, allowing further cooling and condensation and permitting contamination of the air by iron rust and scale. At this time innumerable interconnections existed between the instrument and yard-air lines, principally to bolster instrument air pressure on a spot basis. Interconnections were without knock-outs or other protective devices, and further air contamination was inevitable. Moreover, at several places service air for maintenance was occasionally being taken from the instrument air headers.

In late 1945—in fact, as soon as World War II was over—studies aimed at improving Baytown's instrument air supply were begun. Operating and instrument maintenance people brought forward an impressive list of case-history information to support this claim that Baytown could not afford to continue the "status quo." Table 1 presents a listing of the difficulties experienced during the period from 1940 to 1945 that were regarded as being attributable to make-shift or insufficient instrument-air conditioning facilities.

The cost to Humble of these incidents was estimated to be about $90,000—and the weather during these years was relatively mild. It was apparent that the company could afford to make an appreciable investment to improve upon this record. Late in 1946 management approval was requested of an installation which would take care of instrument-air needs of all refinery process units excepting Baytown Ordnance Works. Inclusion of this area in the central system was deferred, partly because of its remoteness from the rest of the refinery at that time.

Description of System—The project undertaken in 1947 and 1948 cost approximately $59,000 and comprised the following steps: (1) provide new trunk headers and laterals to operating units throughout the refinery; (2) eliminate miscellaneous tie-ins between the yard air system and existing instrument air lines; (3) establish central feeder points to the new instrument air system at Air Stations 1 and 2, taking 100 psig air from the existing yard air compressors; (4) install commercial air dryers at each air station, with auxiliary oil-knock-out and dust-removal facilities; (5) make one low-pressure-actuated tie-in of yard air to the instrument header within each process unit for emergency air supply in the event of central-system failure; and (6) provide instruments for flow measurement and pressure control. Subsequently, dew-

TABLE 1

Operating Difficulties Due to Unsatisfactory Instrument Air System, 1940-1945

UNIT	Lost Time	Cause of Outage	Source of Air Supply
Light-Ends Fractionating and and Alkylation Unit	32 Hrs.	Icing during freeze	Small compressor with aftercooler and knock-out drum. Carbon steel headers. Some air dried in activitated bauxite or kerosine dryers, but not regenerated.
Naphtha Fractionating Unit.	8 Hrs.	Icing during freeze	Similar to above.
Propane Lube Plant.....	6 Hrs.	Icing during freeze.	Air drawn from industrial system through calcium chloride dryers which could not be regenerated.
Naphtha Rerun Unit & Associated Equipment (13 large super-fractionators)	8 Hrs.	Icing during freeze	Air drawn from industrial system through activated bauxite dryers. Regeneration was irregular and water was normally carried over into the instruments.
Fluid Catalytic Cracking Unit No. 2	3 Days	Faulty line-up made around unit air dryers, shutting off air supply	Independent compressor, make-up from industrial system. Activated bauxite dryers and dust filters. Dryers could not be properly regenerated.
Cracking Coil Debutanizer . .	4 Hrs.	Icing during freeze	Industrial air system.

Meet the Author

R. L. DOCKENDORFF has spent most of his 18 years with The Humble Oil & Refining Company in process design. Now in charge of petroleum and petrochemical process design at Humble's refinery in Baytown, Texas, Dr. Dockendorff also serves as coordinator of a lecture program which brings graduate level instruction to members of the refinery's Engineering Division. His interest in writing dates from his high-school days when he worked part-time as a newspaper writer. He was graduated from Tufts College, where he received a degree in chemical engineering, and completed his Sc. D. at Massachusetts Institute of Technology. He is a member of AIChE and ACS.

point moisture recorders were added at each of the two-air stations to monitor the operations.

Reliability of the system was reasonably assured by virtue of these features of the plan:

(1) *Feeder Stations:* Air Station No. 1 has motor-driven compressors only; Air Station 2 has two large gas-engine-driven units in addition to several motor-driven compressors. Discharge pressure is in the range of 100 to 110 psig. Motor-driven units operate from three different sources of power supply, to give reasonable protection against power failure. Meanwhile, the gas-engine units are large enough to more than satisfy dry-air needs by themselves. A preferential flow of compressed air to the instrument system has not been found necessary at Baytown, although such control has been recommended by others.

(2) *Transmission:* Nominal pressure in the instrument system is about 90 psig, although currently severe dryer station pressure drop is being experienced such that header pressures seldom exceed 75 psig. Main headers have been liberally sized (mostly 4-inch), so that the entire instrument load can be supplied from either air station alone at a pressure not less than about 40 psig at any unit. This operation could continue for several hours since the air dryers have an on-stream cycle time of 8 hours at normal loads. Isolating valves for manual operation are provided at intervals in the main headers.

(3) *Supplements:* An auxiliary air supply to each process unit is provided against the possibility of a line break or other interruption in flow from the central system. Cut-in of such supplementary air is automatic. Details of these facilities are described later.

(4) *Operating Control:* The Utilities department, under the present system, is responsible for dry air, just as for any other utility. Control of dryness, cleanliness, temperature, pressure, and rate can receive the primary attention that is needed. Under the old system, air dryers, if any, were in an area of uncertain responsibility, and as a result, seldom were adequately attended.

Details of System

Distribution System—A simplified flow plan for the system as it now exists at Baytown is shown diagrammatically in Figure 1. Figures 2 and 3 represent the extent and complexity of the distribution system before and after the centralization. These diagrams are approximately to scale. Over-all dimensions of the area give an idea of line lengths; the coding gives line sizing at a glance. The two air stations are favorably located, with the larger capacity unit, No. 2, well suited to the presently proposed expansion to the westward, and ultimate further expansion north-westward.

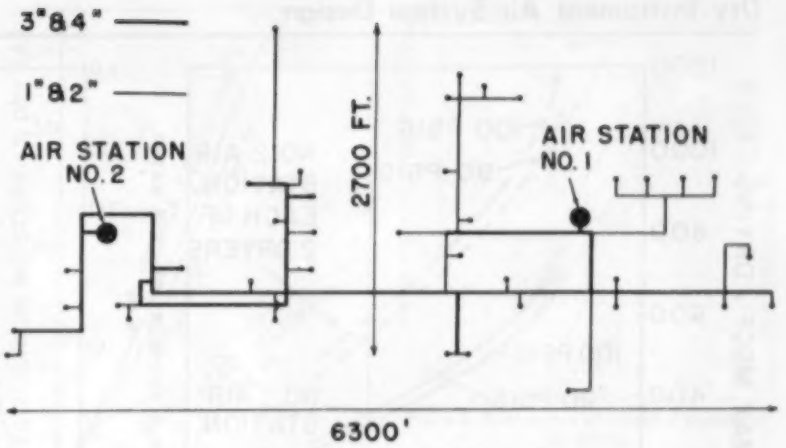

Figure 3. Instrument air distribution, 1954.

Air Station Facilities

Compressors—Referring again to Figure 1, the equipment at the two air-station supply points is somewhat different. At Air Station 1, five relatively ancient synchronous-motor-driven compressors deliver a maximum of 7200 scfm of air at a pressure of about 100 psig. Normally, all machines are kept in operation, with automatic clearance pocket control to permit capacity regulation. Aftercooling to about 100-110 F. in summer (70-80 F. in winter) and condensate knock-out are provided. The nominal diversion of this air into the instrument system is 800 scfm, or about 10 percent of the total available at this station. At times the instrument "take" has exceeded this appreciably; currently the rate exceeds 1100 scfm much of the time. Power service to these five machines is supplied from two independent feeders, one large machine on one feeder and the other four on a second feeder.

At Air Station 2, three relatively modern synchronous-motor-driven compressors team-up with two gas-engine-driven compressors to compress a total of 9200 scfm of air to 110 psig, 6600 from motor-driven and 2600 from engine-driven units. The combined output is cooled to 100-110 F. (summer conditions) before passing through a condensate knock-out drum. Instrument air removed from the total stream at this point was originally 1200 scfm maximum; this has now been increased to over 1900 scfm, as compared to a nominal capacity of about 2600 scfm. Power supply for the motors is from a single feeder, separate from the two serving Air Station No. 1. Therefore, practically the entire refinery instrument air load is protected from either power failure or gas engine downtime.

Aftercooling—High-pressure air diverted to the instrument air system at each station is processed in equipment substantially identical except for size. At Air Station 2, the air is further cooled for maximum water knock-out with an additional aftercooler. The significance of this step is shown in Figure 4. Cooling the air an additional 10 F. in the vicinity of 100 F. and 100 psig can increase the capacity of a drying bed by 30-40 percent. With cooling water generally available in the Gulf Coast area at a maximum of 70-90 F., it can become very costly to reduce the air temperature much below 95-100 F. Here, then, is the place to calculate an economic optimum. Since it is important to prevent condensation at all times of the year, rather than winter-time freezing alone, the design must provide capacity for summer-time operation, although dryness requirements may be relaxed considerably.

Designs on Air

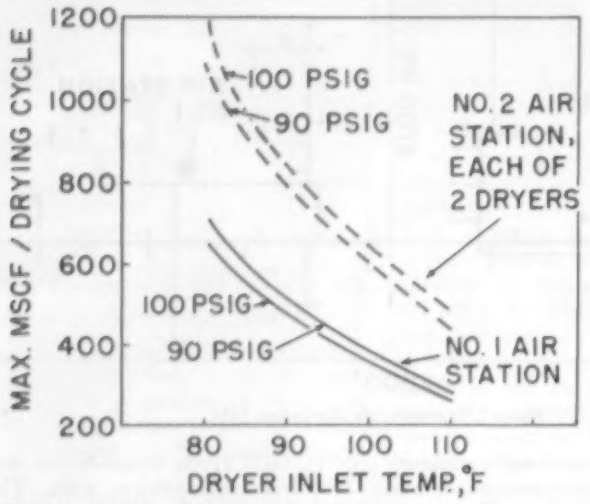

Figure 4. Maximum dry-air capacity vs. temperature of saturated air to dryers, based on water take-up of 10 weight percent on alumina.

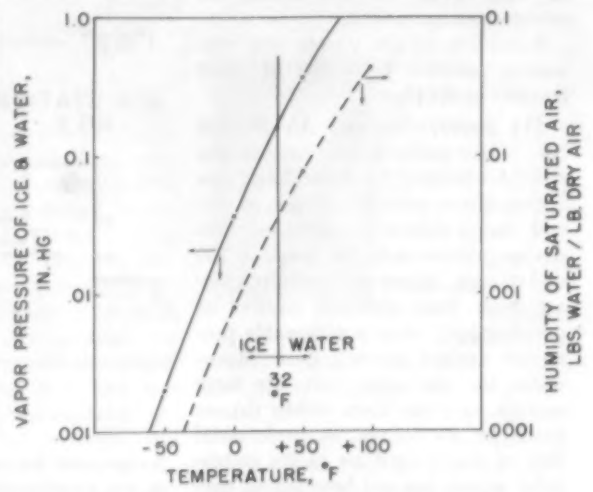

Figure 5. Relationship between vapor pressure, humidity, and temperature.

Another feature of this calculation is the use of refrigeration to further reduce the air temperature and its saturation moisture content. Of course, refrigeration is expensive, too; but in some cases it is optimum to remove the bulk of the water by such fore-cooling, and to trim to a low final water content with a desiccant bed. For example, it was found in a study at Baytown several years ago that to obtain dry air at 35 psig it is optimum to refrigerate to about 50 F., thus obtaining about 80 percent removal of the water of saturation at 100 F. and 35 psig, with the final 20 percent removed in a desiccant-type unit. At a pressure of 100 psig the saturation water is about one-third as great as at 35 psig, so there is less incentive to combine the two types of water-removal equipment.

Condensate Knock-out—Liberally-sized water knock-out drums are in use at both air stations. However, there is some evidence that these and other knock-out drums following air after-coolers probably should be provided with mist eliminators, such as crinkled-wire-mesh pads. Although an appreciable part of the condensate produced in the after-cooler is formed at the tube wall, and will agglomerate and flow as liquid into the separator, the conditions also permit the formation of a mist or fog in the main air stream, only part of which at best can be removed even with a mist extractor. A fog is formed by the condensation of fine droplets of liquid out of a saturated vapor system, when the cooling is by mixing with another colder, saturated vapor stream. Over a wide range of proportions, such a mixture will be below its dew point (incipient condensation temperature), and if nuclei are available, such as dust particles, or if the system is mechanically disturbed, as by turbulence within an exchanger, condensation into suspended liquid droplets can occur. Unless such fog is largely dissipated, the moisture to be removed in subsequent dryers will considerably exceed the amount calculable at saturation. Drum-sizing criteria are well known to designers, and manufacturers are able to supply information on mist extractors, so these subjects will not be dealt with here.

Dryers—The drying step proper is probably the feature of greatest interest. Numerous drying agents may be considered, their acceptability depending upon dryness required, transmission pressure, size of system, utilities for regeneration, and cost for initial and replacement charges, among other factors. A rather thorough listing of desiccants is available.[3,4]

The accetpable moisture content of air dried for instrument use is related to the ambient temperature for which protection against icing or water accumulation is desired. The lowest temperature attained by the air may be at the point of release to atmosphere, since expansion from higher pressures is accompanied by a slight cooling effect, and since the air has then been exposed to ambient cooling for the longest time. Consequently, it is pertinent to measure the "dew point" temperature at atmospheric pressure at which, upon cooling, liquid water or ice can separate from the air stream. However, it may be equally important to measure the dew point at line pressure since in certain cases the air may hold up at high pressure long enough to cool appreciably, and in any event it is desirable to avoid condensation anywhere in the air system. The dew point temperature is a unique function of the water content of the air. It is calculable from the vapor pressure of water and ice at various temperatures. Figure 5 shows such a relationship together with absolute humidity, as found in any psychrometric chart. Note that increments of humidity with increments of temperature get quite small as temperature gets low. In the Gulf Coast area, it is customary to design for an atmospheric dew-point temperature of dried air of 0 F., which is equivalent to a dew point at 90 psig of 42 F., with inlet air saturated at a summertime condition of 95 F. The inlet condition principally fixes the amount of desiccant required as will be developed later. Dryness is related to regeneration, and can easily be carried well below a zero dew point. However, this figure permits some margin for operational defects, including channeling through the bed.

A word of caution: In the case of instruments operated on natural or

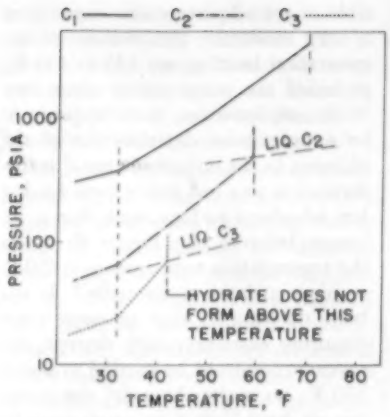

Figure 6. Vapor pressure of hydrocarbon hydrates.

other gases, where these gases can be wet as is usually the case, it is necessary to keep outside the range of hydrate formation. The surest way to do this is to maintain a temperature above about 70 F., regardless of pressure. If pressure is very low, hydrates which form will not be stable but still may be harmful. A non-regenerable desiccant trap may be useful in some cases, and an electrical heating element in others. Figure 6 gives the vapor pressure of hydrates of hydrocarbons commonly encountered in natural gas. For hydrates to form, the gas must be wet enough that liquid water can separate, i.e., at its "dew point"; however, there is some indication that the presence of hydrate actually depresses the dew point of the gas somewhat, permitting hydrates, once formed, to be stable even in the presence of a lower partial pressure of water vapor than that corresponding to the normal dew point. The implication is, then, that only very dry gases, or gases above about 70 F. are completely safe from possible hydrate formation.

As an example of dryer design, consider a dryer using activated alumina. Note on Figure 5 the humidity of air having an atmopsheric dew point of 0 F. (0.0007 pounds water per pound dry air). This is the desired dried-air quality. Note also the vapor pressure of water at this condition (0.0376 inch Hg). Water in saturated air at 0 F. will exert this partial pressure of water vapor; and air of this absolute humidity will exert the same pressure of water vapor when the temperature is 100 F., provided the total pressure remains 1 atmosphere. Now, on Figure 8 locate this condition.

This diagram shows the vapor pressure of water over an activated alumina containing various amounts of adsorbed water, with an additional parameter of temperature. The data upon which this diagram is based may be obtained from the manufacturer of a particular desiccant. Data of this sort on a silica gel preparation are reported by Taylor[7] and by Perry.[8] Air (or certain other fluids) with a given temperature and water vapor partial pressure will equilibrate with desiccant at a unique removable (adsorbed) water content.

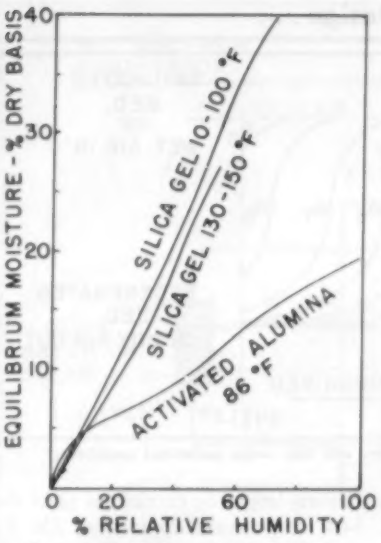

Figure 7. Equilibrium moisture for solid desiccants.

A reasonably obtainable summer time dry-air temperature is 100 F., so we start at this condition. To do so the desiccant must have been regenerated to a water content of 1.70 pounds water per 100 pounds of alumina. Suppose the compressed air at 100 psig has been cooled to 95 F.; its water vapor pressure will be 1.66 inch Hg. Then as this air flows through the dryer, it saturates the first alumina it meets to an extent indicated by Condition (2). The use of cooling water in internal coils prevents the heat of adsorption raising the temperature above 100 F. Farther along, being partly dried, it now saturates the alumina to a value between Conditions (1) and (2). Finally, at the dryer outlet it is nearly dry so it adds very little water to the alumina and it leaves substantially at Condition (1). As time goes on, the alumina at the inlet and progressing through the bed becomes completely saturated at the wet-air condition, and the water removal is occurring deeper and deeper

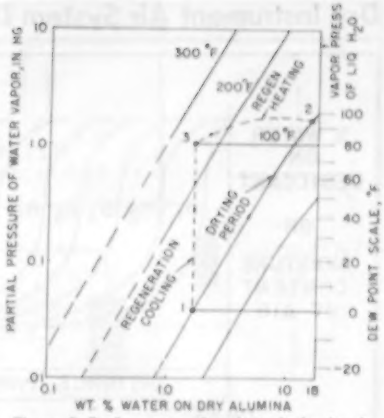

Figure 8. Performance of activated alumina in air drying.

in the bed. Eventually, the wet zone extends to the outlet, and rather abruptly the water content of the dried air rises. This condition is known as the "break-through." In practice, the drying cycle must not be continued to this point, for additional capacity so gained is small and considerable harm may be done by it. Figure 9 gives a series of curves representing the water content within a hypothetical bed at various times during the drying cycle. Cross-plotting the intercepts at bed outlet of time vs. moisture content of the leaving air gives Figure 10. Note the break-through.

Figure 9 also makes apparent another important factor in dryer-bed shaping. Even under conditions where water adsorption is practically instantaneous—and this is hardly the actual case—the time lines slope slightly away from the vertical as required by material balance. For the actual case, with some lagging of the system behind equilibrium, the deviation from the vertical becomes greater. However, a long, narrow bed tends to have a capacity advantage over a short, fat bed containing the same amount of desiccant, because at higher velocities the slope of the curve is not much less steep and the opportunity for channeling is reduced. These phenomena are discussed by Eagleton and Bliss,[5] by Hougen and Watson,[11] and by Jury and Licht,[6] and are further commented upon below.

A certain amount of heat is released during adsorption of water on the alumina. It is practical to continuously cool the bed with cooling

Designs on Air

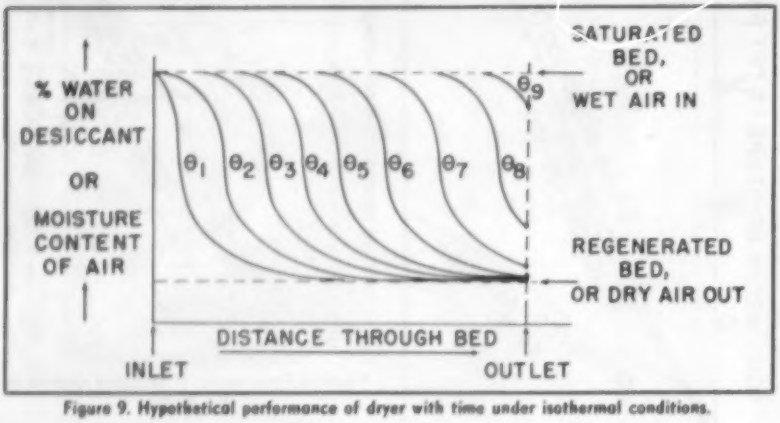
% WATER ON DESICCANT OR MOISTURE CONTENT OF AIR
SATURATED BED, OR WET AIR IN
REGENERATED BED, OR DRY AIR OUT
DISTANCE THROUGH BED
INLET
OUTLET

Figure 9. Hypothetical performance of dryer with time under isothermal conditions.

water in internal coils. In this way the bed may be kept at 100 F. during the drying cycle despite a heat release of about 1100 Btu per pound of water adsorbed. Experiments reported by Derr[10] show that when drying air water-saturated at 72 F. and atmospheric pressure with activated alumina under adiabatic conditions (i.e. no bed cooling), temperatures within the bed in the range of 200-250 F. may be experienced. As time goes on, the outlet of the bed approaches this temperature, and the dryness of the leaving air is correspondingly affected. Holding a minimum temperature contributes to obtaining minimum dry-air moisture content. See Figure 8.

Activated alumina adsorbs water in a reversible manner. Its drying powers can be restored by heating and carrying off the water in a purge gas stream. When a bed has approached the break-through point, its condition throughout will approximate Condition (2) on Figure 8. The bed is removed from drying service and its pressure equalized to atmosphere. A stream of purge air is directed through the bed and vented to atmosphere; this can be a relatively small stream of dry air from an adjacent drying unit, or it can be supplied from the atmosphere by a blower.*

Heat is applied in one or more of several ways: internal steam coils, internal electrical heating elements, sensible heat added from a relatively larger stream of purge air—to name a few. In the case of the use of ambient air as a purge gas, for example, the heating might be carried on until the bed temperature approaches 250 F., and Condition (3), Figure 8, is reached by a path possibly like the one shown. Note that in so doing the alumina water content is restored to the initial value, the water having left in the purge air. It is usually recommended that the desorption conditions be maintained for about an hour after maximum temperature is reached.

Next it is desirable to pass very dry air (such as would be obtainable from an adjacent drying unit) through the bed until it is thoroughly displaced, and then to cool the bed close to the process drying temperature of about 100 F. Embedded water coils do this job very well, particularly for a short cycle where time is limited. Otherwise, it is often the practice to provide for atmospheric cooling only. The cooling step is represented in Figure 8 by a return from (3) to (1) along the indicated path.

Figure 8 represents the performance of a new bed containing a typical grade of activated alumina. The figure predicts that it should be possible to get adquate water removal at a very moderate temperature of regeneration heating, say 125 to 150 F., provided the purge air be quite dry. With use, however, there appears to be a progressive deterioration of the alumina in the nature of crystal transformation to a less active form having less adsorbent surface, such that it no longer behaves like Figure 8, unless the regeneration temperature is 350 F. or more at least occasionally.[9] It has been determined that in some cases requiring extremely high dryness, the regeneration must be carried to above 370 F., no matter how dry the purge gas or how high a vacuum may be pulled on the system. Campbell, Skinner and Lawrence[4] attribute progressive loss in capacity to formation of the stable and inactive alpha monohydrate of alumina. Activated bauxites, perhaps by virtue of their impurities, tend to retain their drying capacity better than does the purer activated alumina. Certain contaminants in the inlet air, such as lube oil from the compressors, will be held rather firmly by the alumina, reducing its capacity to adsorb water.

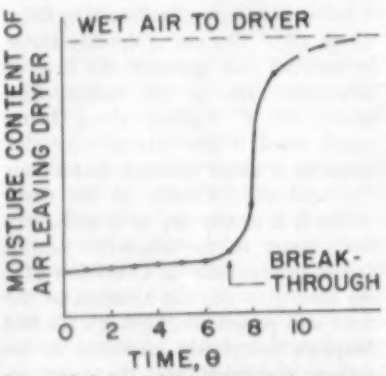

Figure 10. Relationship between air-dryness and time for hypothetical dryer.

Several desiccants of the alumina type perform about the same as activated alumina, differing only as to the vapor-pressure vs. water-content scale. Figure 7 shows comparative adsorption of several desiccants, including activated alumina and silica gel, as functions of relative humidity and temperature. For the alumina, this particular relation is almost independent of temperature; in silica gel there is some variation with temperature. The single line for alumina on Figure 7 becomes the developed function of Figure 8, the conveniences of which should be apparent from the above discussion of regeneration cycles. It is possible, when drying saturated inlet air, to obtain performance of a freshly charged activated alumina dryer showing an average adsorption of up to 10 pounds removable water per 100 pounds alumina, as compared to the 16 to 18 pounds shown in Figures 7 and 8. The difference between these two values reflects the channeling and incomplete saturation of the bed which must be expected with cells of conventional proportions, as compared to an experimental adsorber with a high length-to-diameter ratio. Certain instrument air dryers at Baytown using activated alumina were rated by the manufacturer at 7.7 per-

*For very high dryness it may be profitable, after the bulk of the water has been removed, to pull a vacuum on the bed for an hour while heating is continued. The potential benefits of this may be deduced from the figure.

cent removable water. Some aluminas can be rated only for lower adsorption, some for more. Relatively lower values for design use are listed by Amero, Moore, and Capell[3] and by Campbell, Skinner and Lawrence.[4]

When the entering air is not water-saturated, the theoretical adsorptive capacity of activated alumina, rather than 18 percent, may be deduced from Figure 8. For example, suppose air at 100 F. having a dew point of 30 F. is to be further dried to a 0 F. dew point. The maximum theoretical water take-up by the alumina is 3.7 percent including the water on the regenerated bed of 1.7 percent. Therefore, only 2.0 pounds of water can be extracted from the air by 100 pounds of alumina during a given drying cycle. A design figure would not exceed 1.3 pounds per 100 pounds, and might be as low as 1 pound.

Silica gel is a much higher-capacity adsorbent on a weight basis, having a maximum theoretical adsorptivity of about 40-50 as compared with 18 for activated alumina. However, it is somewhat less rugged than alumina and is considerably more expensive. Both are in use at Baytown. Several branded desiccants that have enjoyed broad use in air drying services may be bought on the market. One of these is a combination of silica and alumina which has intermediate properties. Another is activated bauxite having about two-thirds the initial drying capacity of activated alumina, and somewhat less expensive.

It should be emphasized that the capacity required of a drying bed, and therefore its size, is determined by the amount of water in the inlet air, no more than a given amount of which can be taken up by a bed even at complete saturation. On the other hand, dryness of the processed air with a given desiccant is determined by the regeneration procedure—a combination of pressure, temperature, dryness of the purge gas, and also of time of heating to some degree.

In sizing a drying installation of the regenerative type, it is first necessary to determine the time needed to regenerate with a "reasonable" amount of regeneration equipment. Then an on-stream time is chosen which appreciably exceeds the regeneration time, and which preferably matches a working shift cycle of 8 hours, or one day or one week, if capacity is small. For very large units of high capacity it may be optimum to figure the regeneration cycle very closely regardless of an odd time interval that may result.

The accumulative amount of air to be processed in the selected cycle time is noted and the total water to be removed is calculated. The bed selected should be large enough to provide at least 100 pounds of alumina for each 10 pounds water to be removed per cycle. Then a second bed normally is provided to permit the regeneration of the first without interruption of operations. If regeneration becomes very expensive in a large installation, the optimum may call for three or more cells total, with one regenerating. To keep regeneration

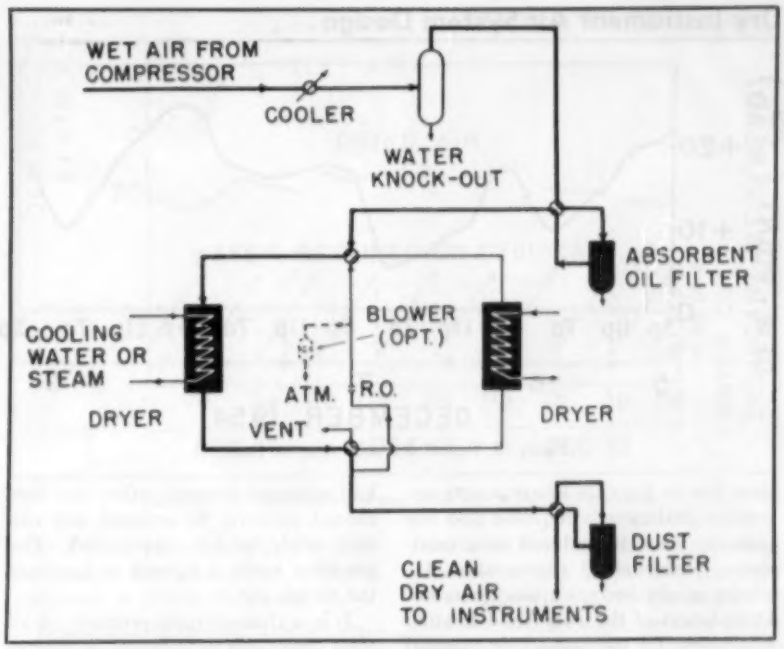

Figure 11. Flow diagram of a typical dryer installation.

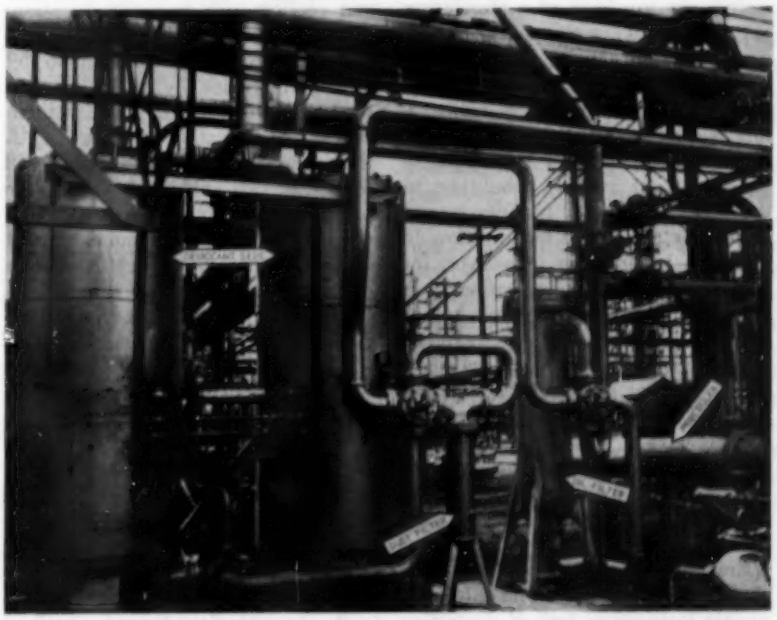

Figure 12. New dryer installation at Air Station No. 2.

Designs on Air

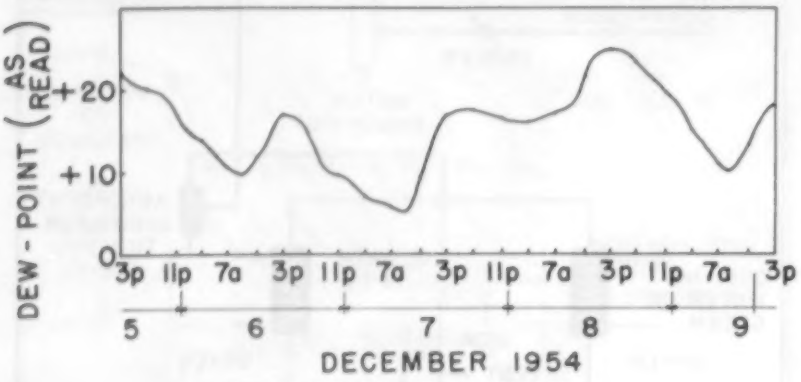

Figure 13. Typical dew-point recorder chart.

time low in the case where a very expensive desiccant is required and the quantity must be reduced to a minimum, "reasonable" regeneration facilities might become quite generous. Calculation of the required heating equipment for the case where external transfer surface is preferred involves mainly the provision of a circulating gas stream having the required heat content to raise the desiccant to about 200-250 F. and to supply the heat of desorption of water, and a temperature 50-75 F. above the desired maximum bed temperature. An acceptable superficial gas velocity would be in the range of 0.5 to 2 feet per second with some preference to downflow to minimize bed dusting. However, for most instrument air applications it is straightforward to select an 8-hour cycle for a large central system and to accept manufacturers' standard heating equipment to fit such a specified cycle. Two swinging cells should be sufficient.

Not only is water carry-over from the compressor aftercooling and knock-out harmful to dryer capacity, but more significant is lube oil entrainment from compressors, as smoke, into the drying system. The only completely satisfactory way of protecting against this is to precede the dryer with a smaller, supplementary cell of the same desiccant. This cell should have a removable element, with a spare element stored close by, such that the elements can be exchanged well in advance of an oil breakthrough, on a time schedule. An element of activated alumina can be cleaned of lube oil by solvent washing to the point where it may be re-used. Manufacturers of dryers customarily offer such pre-filters; Baytown has had adequate demonstration that they cannot properly be omitted, nor can they safely be left unattended. The pre-filter needs a by-pass to facilitate the switch-out.

It is a characteristic probably of all solid desiccants to fragment or pulverize on using, particularly on heating and cooling such as in regeneration. In use over a period of 6 months a desiccant bed will be observed to decrease in volume by say 5 percent, part of which is the result of fragmentation and migration of the solid. Although some of the resulting dust will fill up the bed voids and increase the pressure drop, some also will be entrained to deposit in remote parts of the equipment. Since dust cannot be tolerated in instrument air, it is imperative that a filter be installed downstream of the dryer group. Failure to do so, or prolonged operation with a defective filter will result in dust carry-on into instruments. In several locations Baytown uses with considerable satisfaction a filter having a porous, removable element. This filter also benefits from the presence of a by-pass, although most units of this type can be blown down in service.

A schematic flow diagram of a Baytown air-drying installation is shown in Figure 11. Figure 12 is a photograph of one of the two instrument-air drying installations at Air Station 2, including twin-cell dryers and filters fore and aft, with by-passes. As stated, Baytown had experienced the loss of a cat cracker when instrument air was interrupted during a valve switch at the air dryers. This prompted going to a simple device for a by-pass, such that air flow could at no time be completely stopped during a routine switch. Two-way, four-port cocks were found which have this characteristic (i.e., partial opening of one passage before the other is completely blocked off). The installed cost of one such by-pass was slightly less than for a conventional manifold containing three gate valves. Figure 12 reveals the use of these by-passes.

It was not anticipated initially that it would be necessary to keep a constant check on the dryness of the air, although the rate of flow—particularly accumulative—obviously was of interest if a break-through was to be avoided. Rather, an initial verification of capacity and a periodic check on performance seemed to be enough. Actually, however, a continuous dew-point recorder was found to be indispensible. The performance of Baytown's units, rather than looking like Figure 10, proved to be like Figure 13. Figure 13 is the reproduction of a section of a typical dew-point chart on a dryer at Air Station 2. The measured dew point is the value at operating pressure. The characteristic rise during the daytime and drop during the night with minor, if any, fluctuation at the 3-11-7 o'clock shift changeover from cell to cell, is characteristic of a dryer operating well below its capacity, but with some channeling. Variation in inlet air moisture shows up in outlet air dryness. Air which is completely dried mixes with air which is only partly dry, and the average moisture content of the air leaving the dryer is unpredictable. Channeling can be reduced by careful packing of the beds with desiccant particles closely graded as to size. This is partly defeated by the fragmentation of the particles in use, filling up some of the voids and giving the bed a variable permeability. Effects of channeling can be minimized when beds are long and narrow, and when intermediate open spaces are provided in which equalization of flow can occur.

Figure 14 shows test data taken from the same dryer during about the same period. Dew points have been converted to the basis of atmospheric pressure; all values are well below the design of 0 F. during this period, indicating effective regeneration, but with outlet moisture variations matching those in inlet-air moisture. The accumulated water on the alumina, listed on a separate scale, shows that the loading per cycle is only 2.9

weight percent water on the adsorbent compared to the design capacity of 7.7 percent so this operation does not approach a break-through. The alumina in this dryer had been in use about one year.

Eagleton and Bliss[5] have studied the break-through phenomena experimentally. They report that for air dryers where the inlet moisture content does not exceed about 0.003 pound water per pound air, the rate of mass transfer of water vapor from the air stream into the desiccant so limits the approach to equilibrium at all points in the dryer that even an ideal bed will exhibit an "S"-shaped break-through curve, such as in Figure 10. The curve is flatter at higher velocities. With higher inlet water contents, the curve is similar but less predictable. Atmospheric air, saturated at 80 F., has a water content of 0.022 pounds per pound air; when compressed to 100 psig and cooled to 95 F. its water content is reduced to 0.0046 pounds water per pound air. Baytown's drying conditions, then, are slightly outside the reported limits of this work, but performance observed qualitatively confirms the generalization. A more comprehensive treatment of calculation methods for adsorption from a fluid stream flowing through a stationary, granular bed is given by Hougen and Watson.[11] Their methods permit a calculation of the time-temperature-concentration-position relationship for such desiccant beds.

Other Facilities—Despite the merits of permitting only clean, dry air to reach process instruments, it is even more vital that compressed air of some quality be available at all times. To protect process units against a line-break or other failure in Baytown's tenuous dry-air distribution system, there was installed at each major unit one interconnection with the yard air system. Various types of jumpovers were installed; but all had in common these features:

(1) knock-out pot on yard air in jumpover line,

(2) pressure control valve to open only when instrument header pressure drops below a given value,

(3) check valve against back-flow into yard air, and

(4) check valve against back-flow from within unit to outside dry-air header.

In some cases, existing unit dryers were kept in place and piped into the jumpover. An example of a typical jumpover is shown in Figure 15.

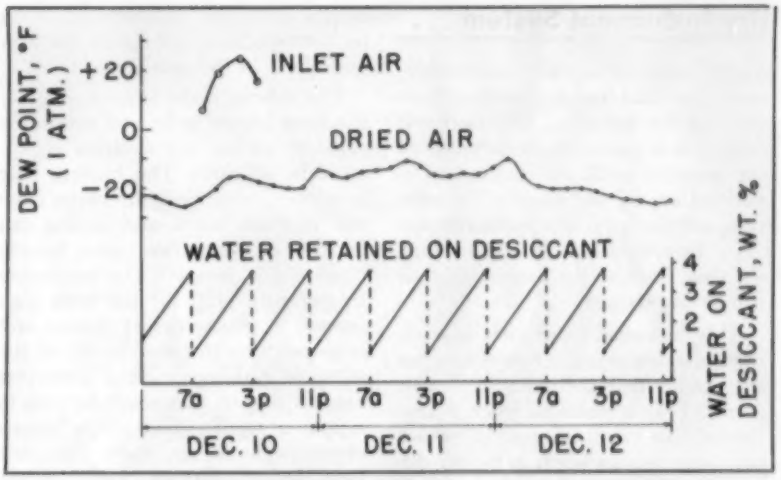

Figure 14. Test performance of new dryer unit at Air Station No. 2.

Materials—Materials and equipment items which have given good service at Baytown can be listed:

Piping—Galvanized steel for all new headers and laterals.

Dryers—Activated alumina dryers with regeneration by internal heating coils of KA_2S pipe (½ inch) with welded-on carbon steel or alloy steel fins, two 2500-pound twin-cell units and one 1500-pound twin-cell unit; elsewhere in the refinery are another 750-pound twin-cell unit, with galvanized steel coils and a silica gel dryer with regeneration equipment entirely external to the beds. All have 8-hour process regeneration cycles, with heating by 150-pound steam to bed temperatures of about 150-250 F., followed by water cooling to 100-120 F. using the same coils. Regeneration is manual for the alumina dryers and automatic for the silica gel unit. This resulted from an exercise of local preference among the operators; the additional cost for automatic operation probably cannot be justified for units on an 8-hour cycle. Spare charges of alumina and silica gel are kept in the warehouse at all times.

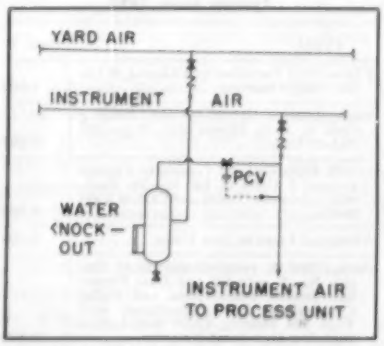

Figure 15. Typical yard-air supplement to instrument air at process unit.

Filters—Oil filters are those recommended by the manufacturer to precede his dryers. For Baytown's alumina dryers, the pre-filters contain either 100 or 200 pounds of alumina in a removable cartridge. A drain at the bottom permits discard of accumulated lube and any other contaminant that can be trapped out of the air to the dryers. A spare cartridge was obtained for each filter and is kept nearby to facilitate replacement and servicing at regular intervals. The cleanable-element dust filters located after the alumina-filled dryers containing porous stone elements have given excellent service despite one broken element which permitted some getaway of desiccant fines before it was discovered. Figure 12 shows an installation of both types of filter at Air Station 2.

Dew Point Recorders—The dew point of the air from each dryer is recorded by a continuous dew-point instrument. To measure dew point this instrument employs a saturated salt solution containing two electrical conductors. With a constant voltage across the conductors, the current flow varies with the conductivity of the salt solution. In turn, the conductivity is related to the moisture content. As the humidity of the air around the cell increases, the solution will tend to

Designs on Air

absorb water. This raises the conductivity so that more current flows through the solution. The increased current flow raises the temperature of the solution until an equilibrium is reached among the solution temperature, conductivity, and moisture content. By measuring the temperature, the dew point of the surrounding air can be determined.

This instrument measures and records the dew point at operating pressure, rather than the atmospheric dew point. This is desirable since it represents the temperature at which condensation can begin in the air distribution system before pressure reduction for instrument use.

One limitation of the measuring system should be pointed out. When the relative humidity of the air is very low, the salt solution will lose all of its water and cease to conduct current. When this point is reached the instrument responds only to changes in air temperature and not to dew point. The process is reversible, so that when the humidity of the air increases, the cell will again begin to measure dew points. The manufacturer's rating information indicates that our instruments should measure dew points under practically all conditions we may encounter.

The installation of the dew point recorders is shown in Figure 18. An air sample is taken from the main line upstream of the flow-measuring orifice, passed through the cell and returned to the line downstream from the orifice. Two of the three instruments are equipped with alarms set to blow a whistle when the dew point exceeds a set value. The set values for the two alarms are dew point values of 60 and 82 F. There has been no incentive to reset these alarms to match seasonal variations in ambient temperatures since the dryers have some excess of capacity.

Problems and Characteristics

Experience with the two compressor stations, with multiple compressors on gas-engine and on motor drive, supplied by several circuits indicates that this provides sufficient protection of continuity of compressed air supply. There has been at least one power failure when the three motor-driven units at Air Station 2 have been lost and full air supply in that area came from the engine-driven compressors. There has been no corresponding outage at Air Station No. 1 in the past six years.

The 8-hour cycle lengths in practice have proved to be well within the capacity of the regeneration equipment in all cases. The heating time to maximum temperature varies from two to three hours, and cooling can be done in one to two hours, leaving considerable leeway. The maximum temperature (250 F.) has been high enough to give sufficient dryness and to permit one to two-year life of the alumina. Although some of the dryers came equipped with small blowers to supply a regeneration purge stream of atmospheric air, these have not been needed. Instead, a slip stream of dried air is diverted through a unit on regnereation; this stream has hardly exceeded 3 to 5 percent of the normal thruput. Displacement is about all that is required provided there is an internal source of heat.

Life of the alumina has varied from one to two years, averaging about 1.5 years. The practice has been to open and inspect each dryer cell on a yearly schedule. If the bed appears discolored from lube contamination, or if the drying of air has become inadequate, the alumina is changed. Otherwise, the bed is retained for another year.

Keeping the dryer pre-filter in good shape is vital to the success of the operation for more than one reason. The accumulated oil, if allowed to wet the filter cell entirely, will eventually come through and lay down on the dryer bed. Lube contamination reduces the capacity of the bed to take up water, and is not corrected by regeneration. A regularly scheduled swap-out or naphtha-cleaning of filter cartridges therefore is mandatory. The proper frequency is related to compressor operation, and can only be determined by trial. One to three months is about par. Baytown has found its oil filter also trapping out additional water condensate, particularly during periods of cold weather when line cooling is considerable. The advantage of this is obvious.

Both dust and water at times have penetrated well down the line due to faulty equipment or operation. The broken filter element has been referred to above. The principal sources of excess water in the instrument air lines have been (1) bed channeling, (2) steam-coil leaks, and (3) faulty interconnection with other lines. None of these has been much of a factor since early days of operation of the system. A certain amount of skill was needed in packing alumina around the finned coils; some beds were repacked two or three times before a satisfactory result was attained. The bed removals in turn had been required when steam coils originally furnished with the dryers sprung leaks within two months' operation. Coils at that time were of galvanized steel, and were identical to others in a unit that had operated for two years without evidence of undue corrosion, in another part of the refinery. It was concluded that the steam must be more corrosive in one area than the others, and that in view of the uncertainty very high-grade replacement coils could be justified. The replacement was with stainless steel, and there has been no further trouble to this date. Figure 17 shows the original coil in place before replacement of the alumina. The corrosion failure was localized pitting on the steam side and does not show in the photo. Some flaking-off of the galvanizing was noted on the outside in

TABLE 2

Summary of Appropriation Close-Out Costs, 1948 Installation

ITEM	Cost, $
1 1500-lb. twin-cell dryer unit, with Oil Filter, Dust Filter, Utilities Supply and Foundations	10,000
1 2500-lb. twin-cell dryer unit, with Oil Filter, Dust Filter, Utilities Supply and Foundations	13,900
Flow Instruments and Pressure Control Valves	4,300
Piping, Including New Galvanized Steel Headers Throughout the Plant, Laterals to Operating Units, and Air Piping Changes at Operating Units	39,800
Total Initial Investment in New Facilities	$59,000

TABLE 3

Summary of Capital Additions to Dry-Air System Since 1948

ITEM	Cost, $
2 Dew Point Recorders and Alarms, at the Two Dryer Stations	1,500
Replacement of Galvanized Steel Heating Coils in Both Dryers with Type 347 Finned Coils	13,300
Install Additional Air Coolers to Precede Dryers, 2 Units of 540 Sq. Ft. Each, with Admiralty Tubes and Carbon Steel Shells	6,800
Additional Lines to New Units	8,700
Second 2500-lb. twin-cell dryer at Air Station No. 2, with Oil and Dust Filters, Instruments, Foundations, and Piping Connections; Dryers Equipped with Type 304 Heating Coils; Instruments Include a Dew Point Recorder	22,900
Total Supplementary Investment	$52,200

contact with the alumina, principally at the air-inlet part of the coil where liquid water possibly might collect.

One of the real problems with the central system—particularly one retaining components from earlier facilities—is protecting the system from mis-use. Process foreman in all areas and utilities distribution foreman thoroughly policed the Baytown system to find and dismantle all extraneous connections into the dry-air system at the time it was put into operation. Still, years later, an extraneous connection occasionally is found which was either overlooked initially, or has been added later without the knowledge of the Utilities department. Some time ago a 1-inch steam line, wide open, was found connected into the dry instrument air header. It took several days after the disconnection for the system to dry out. There are perennial requests for permission to use the dry air for everything from comfort conditioning to tank blowing. It has required a clear policy, and firm, centralized control to keep the situation in hand. Despite slip-ups here and there, the system has provided dry air when it was important and freeze-ups have been eliminated in the areas served by the central system.

Costs—A summary of the actual investment in 1947-48 on the central system is given in Table 2. Investments in subsequent years to increase the capacity of the system to 3400 scfm of dry air and to make it available to all the units indicated in Figure 3, are given in Table 3. While this adds up to an investment of only $33 per scfm, a considerably higher figure, about $85 per scfm, should be considered for the total cost of the present facilities by virtue of the distribution lines earlier in use that were incorporated in the central system (Figure 2), and because compressed air at 100 psig was diverted from existing compressors.

Conclusion

After more than six years of use it is apparent that Baytown's central system is here to stay. After correcting initial difficulties, a relatively stable and satisfactory operation has been established. One expansion to two-fold capacity already has been made at Air Station 2 as more processing units have been added. There is little reason for further delay in extending a main header the rest of the way to the group of units formerly known as the toluene plant. The favorable evidence is not lacking: during a freeze in 1951 the toluene plant units and several process units at the nearby government-owned rubber plants were largely shut down due to icing, whereas the balance of the refinery process units were unaffected. Most of the auxiliary devices provided with the original job have been retained, notably the low-pressure-actuated cut-ins. Headers have been extended to new units.

Original presentation was at the Symposium on Instrumentation for the Process Industries, A. & M. College of Texas, College Station January 26-28, 1955.

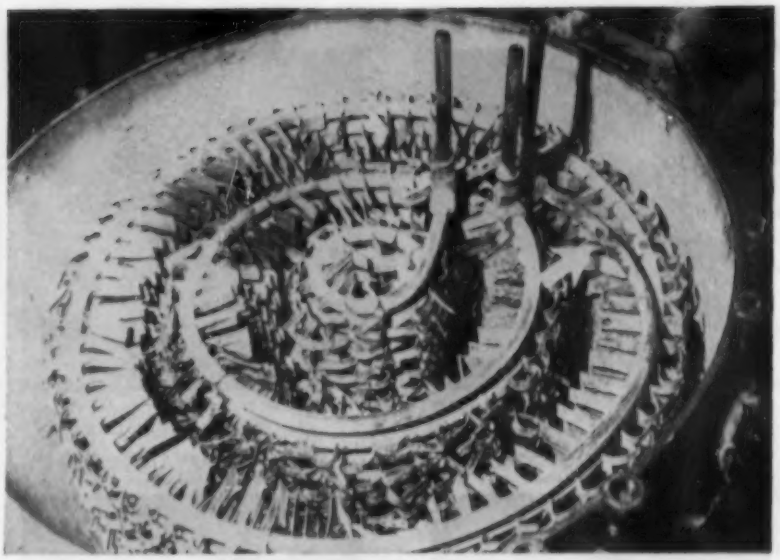

Figure 16. Heating coil nest in place in dryer, with alumina removed. Note external failure of galvanizing.

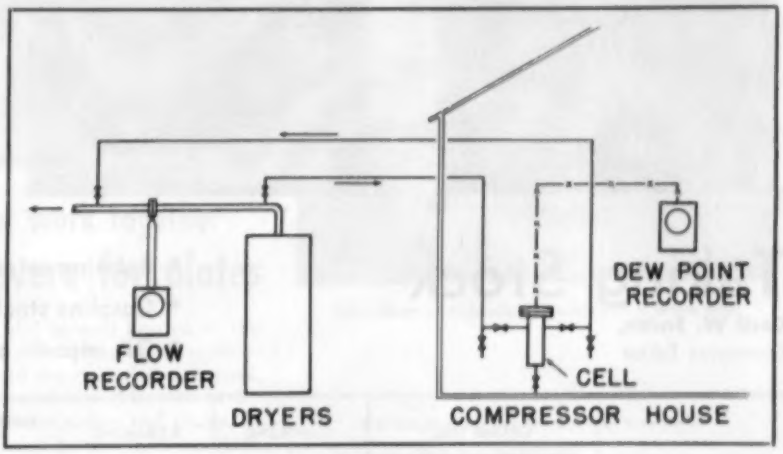

Figure 17. Installation of dew point apparatus.

ACKNOWLEDGMENTS

Thanks are due Humble Oil & Refining Company for permission to present information concerning the dry-air facilities at its Baytown refinery. Assistance in assembling of facts was provided by several co-workers at Baytown, including E. J. Pratt, E. L. Ekholm, C. W. Bates, W. H. Fortney and H. C. Lyles.

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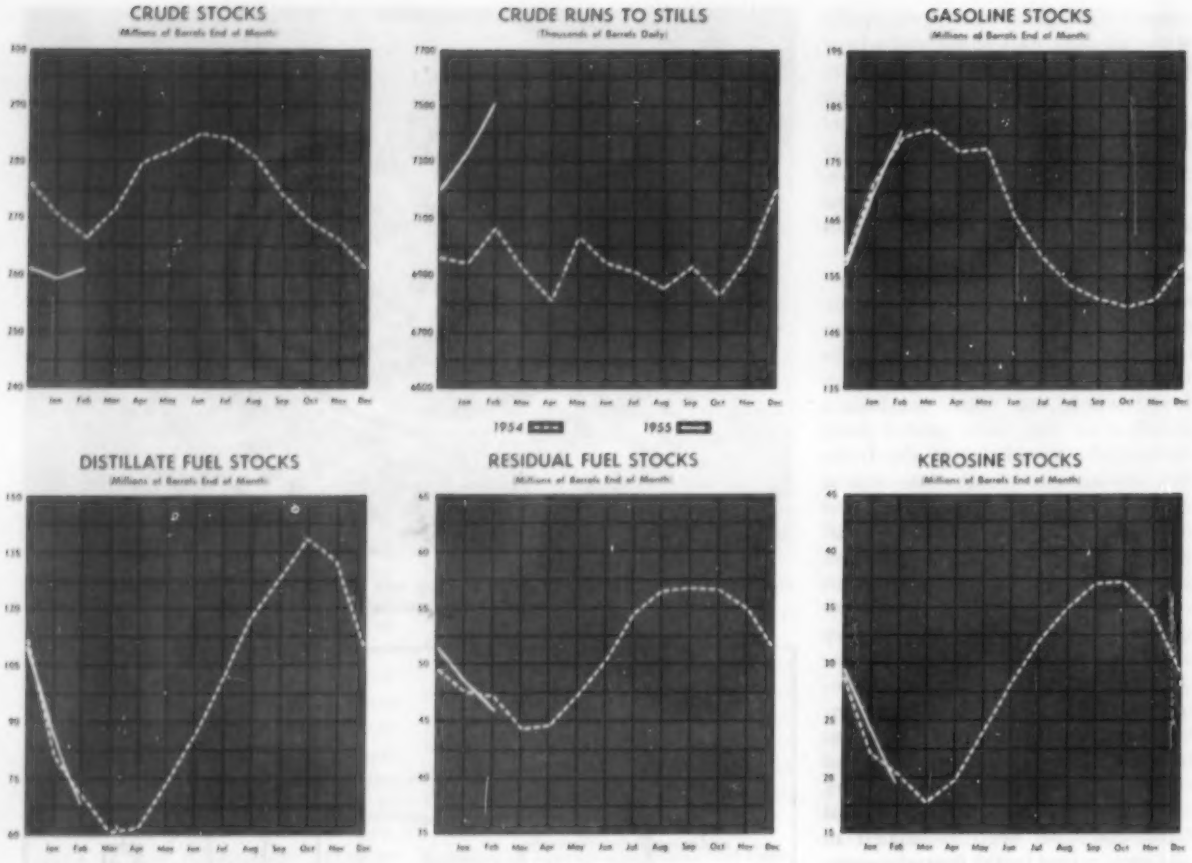
(End of Symposium)

Designs on Air



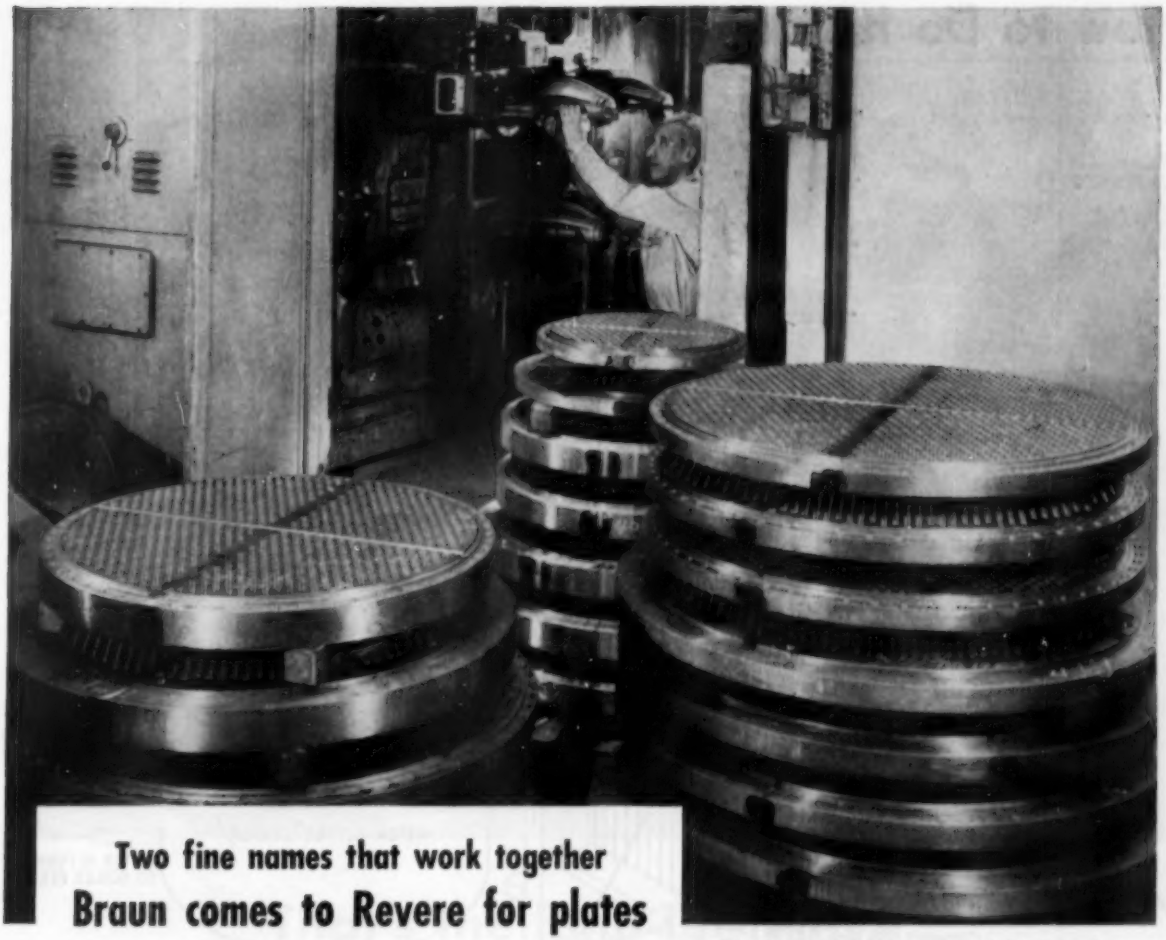
Taking Stock

Cecil W. Smith,
Economics Editor

- Refining rates reach new high mark
- Gasoline stocks hit highest level
- Oil imports also gain high point

MONTH	CRUDE OIL			GASOLINE		KEROSINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1953:													
February	6,562	6,969	273,589	3,379	157,873	404	20,468	1,505	67,167	1,275	44,178	586	1,066
March	6,531	7,002	275,665	3,319	162,731	359	18,697	1,489	59,802	1,256	41,600	655	1,112
April	6,446	6,781	280,487	3,282	158,032	369	20,335	1,424	61,349	1,219	39,572	628	1,010
May	6,390	7,002	280,308	3,366	156,415	327	24,307	1,400	73,706	1,197	41,795	703	1,096
June	6,505	7,081	283,715	3,467	146,196	326	27,659	1,462	84,504	1,238	43,801	707	1,050
July	6,603	7,103	284,976	3,583	143,916	321	31,143	1,441	102,258	1,224	47,530	629	950
August	6,583	7,163	285,362	3,592	146,050	321	35,711	1,437	119,542	1,222	50,007	672	946
September	6,557	7,023	289,614	3,521	144,184	330	37,280	1,448	126,709	1,203	50,516	692	1,013
October	6,262	6,872	287,541	3,437	144,495	355	38,161	1,462	135,409	1,184	50,820	639	990
November	6,277	6,987	283,021	3,528	150,747	354	36,271	1,463	133,381	1,223	51,267	648	1,120
December	6,238	6,964	276,676	3,628	159,949	378	29,070	1,441	111,944	1,247	49,370	598	1,121
1954:													
January	6,240	6,947	270,811	3,431	171,704	390	22,013	1,467	81,044	1,271	47,474	617	1,143
February	6,379	7,068	266,918	3,476	179,950	412	20,183	1,545	70,390	1,241	47,119	621	1,144
March	6,507	6,923	271,887	3,375	181,297	353	17,533	1,458	60,270	1,168	44,249	654	1,068
April	6,615	6,811	280,310	3,404	177,006	322	19,656	1,374	61,721	1,140	44,362	574	950
May	6,471	7,038	282,250	3,482	177,606	302	23,892	1,372	73,581	1,148	47,009	708	1,021
June	6,500	6,947	285,155	3,483	165,404	306	28,184	1,399	86,325	1,123	50,216	624	999
July	6,242	6,916	284,894	3,480	158,010	295	31,953	1,416	101,657	1,089	54,365	724	1,038
August	6,168	6,862	281,043	3,492	153,168	302	34,949	1,453	117,579	1,069	56,332	664	966
September	6,151	6,939	274,608	3,511	150,916	301	37,099	1,514	128,061	1,086	56,702	672	999
October	6,135	6,834	269,442	3,457	149,661	310	37,140	1,545	139,128	1,066	56,541	642	1,065
November	6,346	6,975	264,596	3,530	150,604	354	34,547	1,622	133,886	1,120	54,891	636	1,104
December	6,394	7,238	258,385	3,605	155,400	381	27,826	1,668	108,144	1,187	52,105	729	1,301
1955:													
January	6,665	7,343	250,828	3,534	170,349	393	23,961	1,743	86,019	1,218	48,236	720	1,304
February	6,759	7,501	260,316	3,547	181,753	368	18,826	1,812	67,531	1,245	45,072	789	1,365
Week Ended:													
3-25-55	6,863	7,334	263,943	3,398	184,157	315	18,890	1,683	62,657	1,150	46,050	607	1,209
4-29-54	6,452	7,000	266,942	3,372	178,628	341	17,800	1,455	60,654	1,196	44,093	655	1,061

Source: Data for last two months from API; prior monthly data from Bureau of Mines. Data in thousands of barrels.



Tube sheets at 4-spindle automatic drill in Braun shop.

Two fine names that work together

Braun comes to Revere for plates

C. F. Braun & Co., Alhambra, Calif. is well known in the petroleum industry, the chemical industry, and other businesses in which heat transfer and fractionation are vital. Revere Copper and Brass Incorporated is well known in the non-ferrous metal industry for its tube sheets and plates, in all the customary alloys. What is more natural than the close relations between the two companies, Revere the supplier, Braun the fabricator? Revere can furnish heavy plates when needed; Braun is one of the great heavy-duty shops of the country. So far as transportation limits permit, Braun fabricates in its own plant; their machines and their cranes can handle anything the railroads can haul away. The same is true of Revere, which is likewise known throughout heavy industry for its ability to produce not only large plates, but also condenser and heat exchanger tubes.

Revere is pleased to be an important supplier to Braun. Remember, good names find it good business to come together. The next time you want quotations on tube sheets and plates, and condenser tubes, get in touch with the nearest Revere Sales Office.

A Braun engineer inspects a drilled tube sheet.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

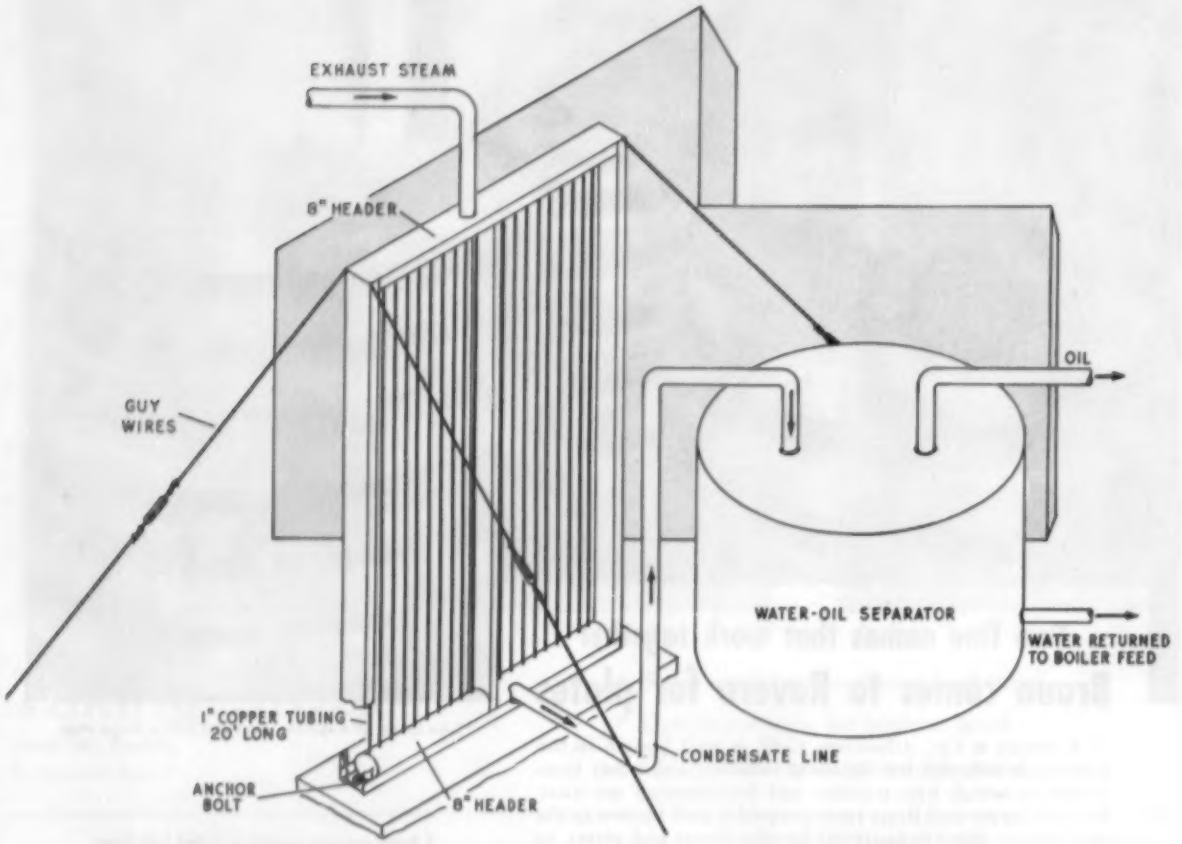
230 Park Avenue, New York 17, N. Y.

• • •

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N.Y. Sales Offices in Principal Cities, Distributors Everywhere.

For more data on advertised products, use Readers' Service Cards, last page.

$10 is paid for each accepted idea. Mail to Editor, Petroleum REFINER, P.O. Box 2608, Houston, Texas



Put Exhaust Steam to Good Use

. . . Water shortages make atmospheric condensers attractive money savers.

Water shortages or high-cost water can make the use of atmospheric condenser to recover exhaust steam very attractive. This shop-made unit is utilized by a natural gasoline plant in West Texas to do the job at low cost.

The unit consists of one or more banks of tubes erected vertically and a vessel for use as an oil-water separator. The tubes, one-inch in diameter and 20 feet long are rolled into headers at each end. The unit is then mounted into a structural frame. The separator can be any vessel with sufficient residence time to give satisfactory separation of the oil from the water.

Exhaust steam is fed into the top header. As it flows down the tubes, it is condensed by the cooling action of the wind. Condensate is collected in the bottom header and sent to the separator vessel. The oil floats to the top and is removed. The water is pumped from the bottom of the vessel to feed water storage.

Condensate recovery has another advantage. In many cases available fresh water is high in mineral content and leaves deposits in the boiler in those plants without water treating facilities. The condensate is essentially free of any contamination except perhaps a trace of oil.

See other How to Do It items on next page.

That's the long-life valve on sulphuric acid

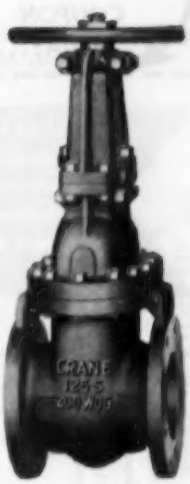
THE CASE HISTORY: At a large midwestern refinery there were recently two valves of different makes on a 90% sulphuric acid line. As seen in the photo above, these valves worked under identical conditions, almost side by side—each operated about three times daily.

Less than a year in the line, the valve at left started leaking, with the leak getting rapidly worse. In contrast, the Crane No. 475½ all-iron gate valve at right, with two years' continuous service to its credit, was still giving completely good performance.

That's Crane quality in valves—with a 100-year background in quality manufacturing. That's why Crane valves are the first choice of thrifty buyers in the petroleum industry as in all others. Crane Co., General Offices, Chicago 5, Ill. Branches and Wholesalers serving all industrial areas.

CRANE IRON BODY WEDGE GATE VALVES

Here are valves of unusual strength for their 200-pound W.O.G. rating. Body and bonnet are oval shaped, with extra metal where needed most. Their Crane-quality cast iron with highly engineered operating design makes these valves outstanding performers wherever they're used. A complete family to choose from. See your Crane Catalog or your Crane Representative.



CRANE CO.

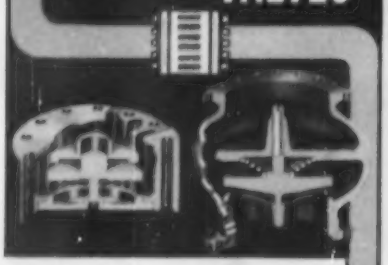
VALVES • FITTINGS • PIPE
KITCHENS • PLUMBING • HEATING

CRANE'S FIRST CENTURY...1855-1955

For more data on advertised products, use Readers' Service Cards, last page.

For Positive Low Cost
PROTECTION
of your piping system
SILENT SERVICE SINCE 1929

WILLIAMS-HAGER
FLANGED
Silent
CHECK VALVES



for all piping systems handling water, acids, oils, gas, alkalies, other fluids.

Built to meet exacting service requirements—in sizes from 1" to 20"—Williams-Hager Check Valves will eliminate costly and dangerous *water hammer* in your piping system. Can be installed in horizontal, vertical or angular position. No special tools required. Send for Bulletin 654!

MAIL COUPON TODAY...

THE WILLIAMS GAUGE CO., INC.
151 Stanwix St., 2 Gateway Center
Pittsburgh 22, Pa.

Please send me a copy of Bulletin 654 on Williams-Hager Flanged Silent Check Valves.

NAME_____
TITLE_____
COMPANY_____
ADDRESS_____
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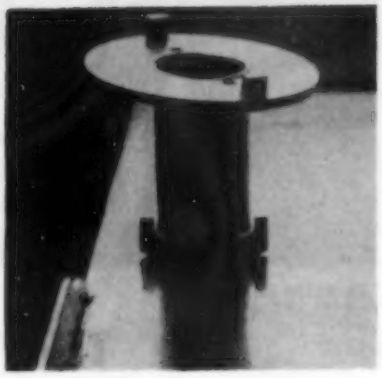
THE WILLIAMS GAUGE CO., INC.
2 Gateway Center · Pittsburgh 22, Pa.

How to Do It...

Outfit a Work Table For Repairing Valves



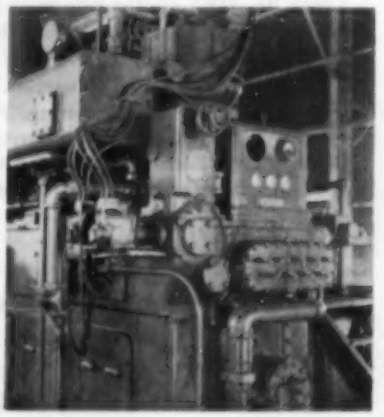
In a large compressor station frequent checks are made on the operation of the compressor valves. To facilitate inspecting and repairing the valves, this combination of valve wrench and workover stand was developed.

The stand is mounted permanently on a work table. It is made of a piece of 3-inch pipe which extends some 6 inches above the table surface. Mounted on the end of the pipe is a circular piece of metal some 8 to 10 inches in diameter having a hole in the center which fits over the 3-inch pipe. Two metal knobs are welded on the outside rim of this circular plate. These knobs are positioned so that they will fit into the valve and prevent it from turning while it is being taken apart.

The valve wrench is also made of scrap materials. The wrench has a single bar with a circular metal piece made to fit the valve. The circular piece provides wrench action. It is welded to the bar at the center which leaves about a 12-inch length of bar on either side for handles.

Enlarged Inspection Plate Aids Gas Engine Repair

Whenever disassembly of the gear system in the magneto and governor setup in a gas engine is necessary, repair time can be reduced from one day to two hours. On engines where the cam assembly is visible through an inspection plate, drill holes in the main housing and use a hack saw to cut out a larger plate. Then, by simply taking off the inspection plate, the cam gear can be repaired and disassembly is much easier. Before, it



THOSE WHO USE IT . . .

CHOOSE IT AGAIN

38.6% of all Hydrocranes Sold are Repeat Orders

Yes, 38.6 per cent of all Hydrocranes sold are additional machines bought by satisfied users. In fact, many owners are now fleet operators — buying a 3rd, 4th, 5th and even a 6th Hydrocrane! Here's real proof that this all-hydraulic truck crane produces big, gives owners real cost savings on a wide variety of jobs.

Only Hydrocrane gives you all these:

- ★ "Reach-ability" with hydraulically telescoping boom.
- ★ Maneuverability with extremely short tail swing, low over-all height.
- ★ Extra stability with four outriggers hydraulically powered and controlled.
- ★ Mobility with speeds up to 50 mph.
- ★ "Control-ability" with full hydraulic power, finger-tip control.
- ★ Convertibility — quickly changed to dragshovel front end in the field.

Plus more for '54.

- ★ Self-power — Hydrocrane has its own independent power unit. (optional)
- ★ Remote control — start it, drive it, turn it, stop it right from the crane cab. (optional)
- ★ Selector unit — foot control channels *extra* hydraulic fluid to hoist valve bank circuit — gives you 50% faster line speed. (optional)
- ★ Increased line speeds — even without selector valve unit, all line speeds are now 10% faster.
- ★ New pressure relief valve — provides even better control of hydraulic pressure.
- ★ Increased crane rating — maximum capacity now 4-ton with 2-part hoist.

Your Bucyrus-Erie Hydrocrane distributor will be glad to arrange a demonstration. See him soon!

REFINERY-PROVED ON ALL THESE JOBS

- Moving heat exchangers
- Handling condensers
- Setting valves and pipe
- Stockpiling material
- Erecting tank foundations
- Trenching

BUCYRUS-ERIE CO., South Milwaukee, Wis.

Gentlemen:

Please send literature on ☐ self-powered and standard Hydrocrane; ☐ self- powered and standard Hydrohoe; ☐ remote control Hydrocrane-Hydrohoe; ☐ wrist-action dipper.

☐ I am interested in a demonstration.

Name_____

Company_____

Address_____

City_____ State_____

43H54

WHAT'S NEW AT BRISTOL

FIRST instrument system BASIC GRAPHIC-PANEL

It's BRISTOL'S new metagraphic instrument system

A WIDE SELECTION: For example, there are 35 receiver and 34 controller models and the widest variety of transmitters on the market. A model can be found among these that will exactly meet any requirement.

FULL PLUG-IN SERVICE: Change recorder to an indicator or vice versa in 10 seconds with ABSOLUTELY NO INTERRUPTION WHATSOEVER TO AUTOMATIC CONTROL.

Pull complete chassis out (one piece chassis — no tools required). With chassis removed you get the same automatic control as before.

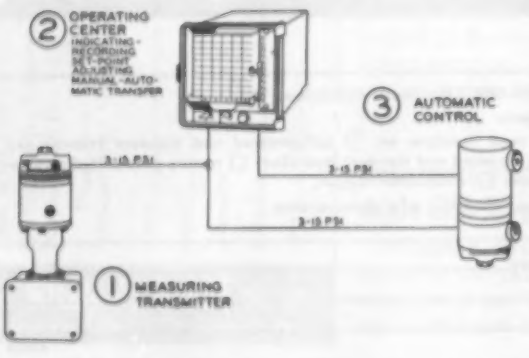
Change from one model to another or if trouble is suspected in a plug-in unit, the doubtful unit can be replaced by a spare while the suspected unit is checked in the service shop — out-of-service time is thus eliminated.

CONTINUOUS VALVE POSITION INDICATION on *same instrument scale as set point scale*, gives continuous data on control valve position—makes "bumpless" transfer possible, simply by matching pointer positions — no need to read actual scale values — minimizes reading errors — speeds operations.

METAGRAPHIC TRANSMITTER

SUPPLIED IN A VERY WIDE VARIETY OF SPANS AND RANGES: For example, absolute pressure instruments are made in ranges as low as 5mm mercury absolute. Pressure instruments as low as 5 inches water to 10,000 psi. Over-range protection available up to 400% over range.

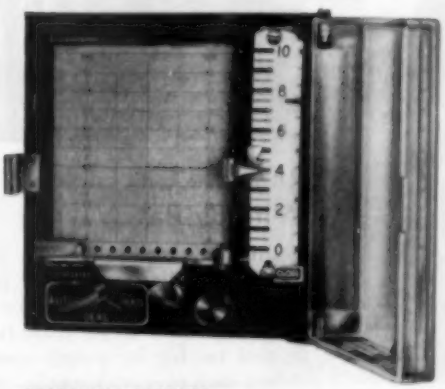
STANDARD BRISTOL MEASURING ELEMENTS ARE USED — high torque, wide-angle travel gives powerful, positive operation. Very sensitive — as little change as 0.03% of range, including reversal.



METAGRAPHIC INSTRUMENTS MEASURE, RECORD, INDICATE, AND AUTOMATICALLY CONTROL

Pressure	Liquid Level
Vacuum	Flow
Absolute Pressure	Temperature and
Differential Pressure	Mechanical Motion

that carries out idea completely!

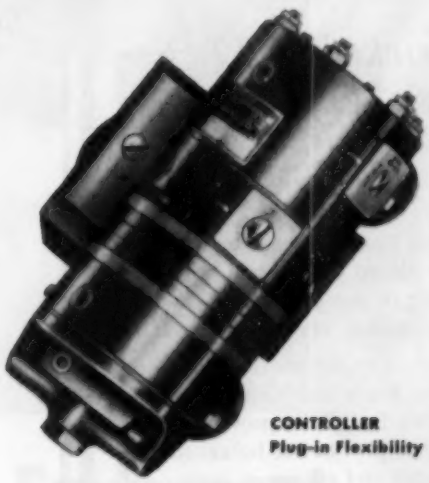


RECORDING RECEIVER:
Also furnished as an Indicator

NO INTERRUPTION WHATEVER TO AUTOMATIC CONTROL when receiver chassis is removed. The chassis of a Metagraphic Receiver is plug-in construction and can be changed from a recorder to an indicator or back in a matter of 10 seconds.

OFFERED FOR UP TO 3 MEASURED VARIABLES — with air pressure regulators or air-loaded regulators — three-position manual-automatic transfer valves for automatic control and *six-position (on the same knob) transfer valves for cascaded control.*

ALL MEASUREMENTS ON SAME SCALE PLATE: Deviation of pointers shows at a glance conditions of control — no need to read scale.



CONTROLLER
Plug-in Flexibility

VARIETY AND FLEXIBILITY: The most flexible and complete line of controllers offered — 34 different models, including the following variations:

1. **Remote set-point**
2. **Integral set-point (with or without air-loading)**
3. **Pipe-connected**
4. **Plug-in receiver mounted**
5. **Plug-in pipe or surface mounted**
6. **Five models of control action as follows:**
   a. **On-Off**
   b. **Adjustable proportional**
   c. **Adjustable proportional plus reset**
   d. **Fixed proportional plus reset**
   e. **Proportional plus reset plus rate (derivative)**

Write for our product data sheets. The Bristol Company, 111 Bristol Road, Waterbury 20, Conn.

6.5.2

BRISTOL'S

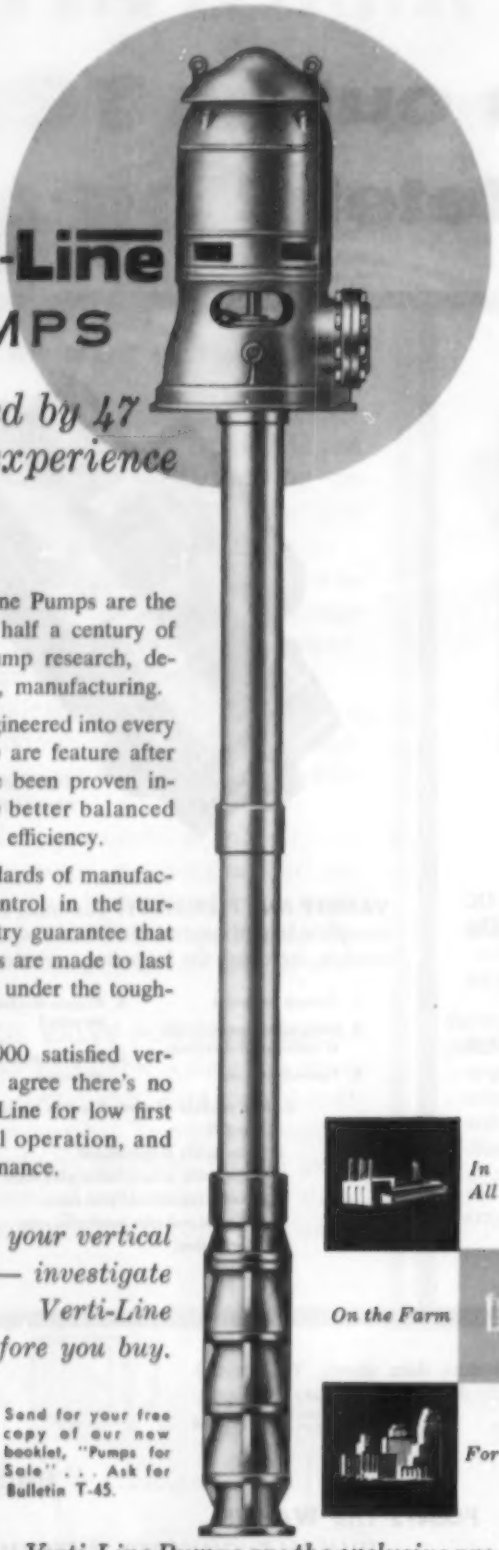
BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

Verti-Line PUMPS

are backed by 47 years of experience



Verti-Line Turbine Pumps are the result of almost half a century of experience in pump research, design, engineering, manufacturing.

Designed and engineered into every Verti-Line Pump are feature after feature that have been proven in-the-field to give better balanced performance and efficiency.

The highest standards of manufacturing quality-control in the turbine pump industry guarantee that Verti-Line Pumps are made to last longer, operating under the toughest conditions.

More than 100,000 satisfied vertical pump users agree there's no pump like Verti-Line for low first cost, economical operation, and negligible maintenance.

Whatever your vertical pump needs — investigate Verti-Line before you buy.

In All Industry

On the Farm

For the City

Send for your free copy of our new booklet, "Pumps for Sale" . . . Ask for Bulletin T-45.

Verti-Line Pumps are the exclusive products of

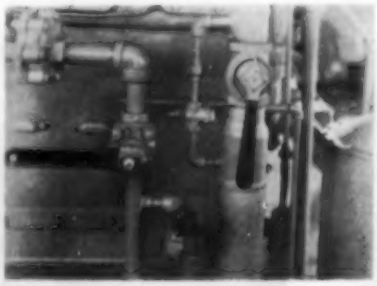
LAYNE & BOWLER PUMP COMPANY

general offices and main plant

2943 VAIL AVENUE • LOS ANGELES 22, CALIFORNIA

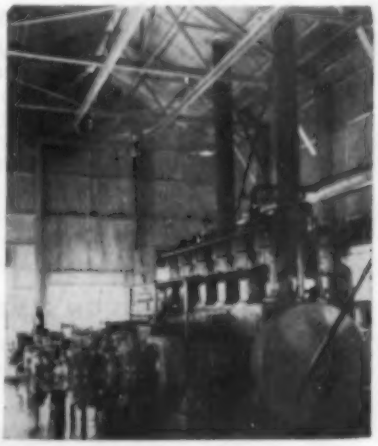
How to Do It . . .

would be necessary to take off all the cam housing, all push rods on the fuel valves and all starting air valves before the cam shaft could be pulled out.



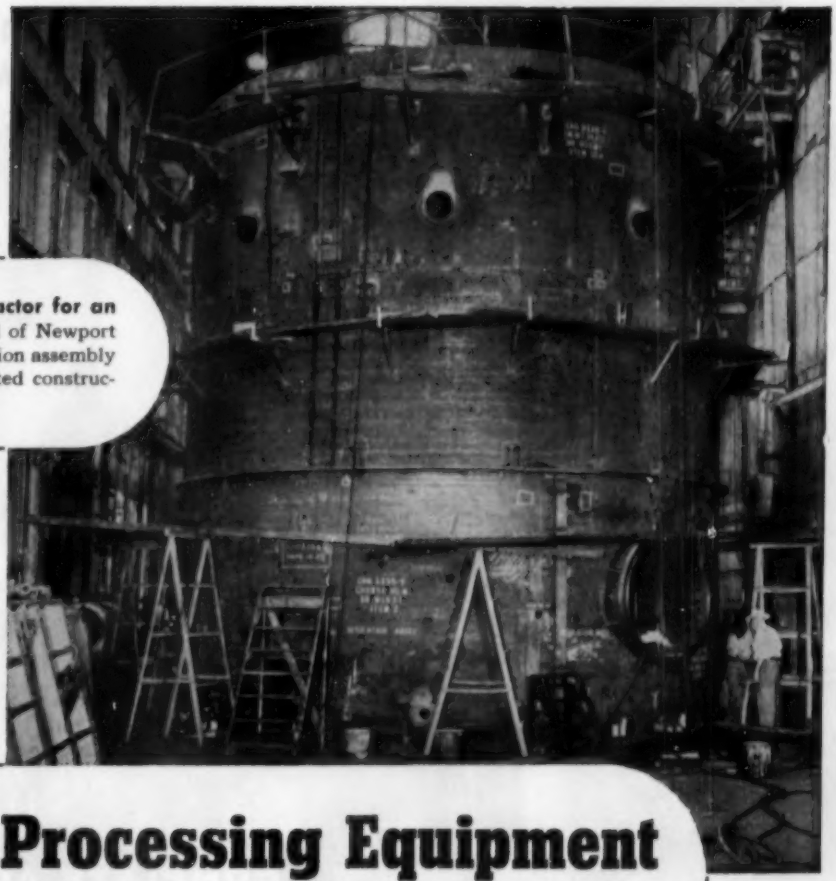
Regulate Gas Engines With By-Pass Valves

On a gas driven engine, starting and idling didn't seem to go just right. The regulation with the three-inch plug valves on the main fuel line seemed too big for proper operation. A half-inch plug cock was installed as a by-pass on the main valve and now closer operation can be obtained.



Double Rail Helps Speed Gas Engine Maintenance

To speed up maintenance on big gas engines, improvise on the monorails found in most compressor buildings. Install a dual rail, as shown above, so that two chain hoists are available and one crew can work at one end of the engine taking off valve heads, while a second crew works unhindered at the other.



Course number four of a reactor for an overseas oil refinery. Typical of Newport News plant methods, the precision assembly of this unit in the shop expedited construction of the reactor in the field.

Petroleum Processing Equipment

...Built by Specialists in Metal Fabrication

Careful attention to detail characterizes the work of Newport News craftsmen...

They've fabricated millions of tons of steel including corrosion-resistant alloy, clad and other special steels for many diverse industries.

Newport News handles the job exactly as you want it done, for maximum results per dollar invested.

Specialized production techniques, advanced plant methods and a complete range of facilities along with many special purpose machines contribute to the excellence of Newport News fabrication.

Let us bid on equipment for your present or future projects. Learn how Newport News can help you...send for our booklet entitled "Facilities and Products." It's yours for the asking.

Newport News Shipbuilding and Dry Dock Company

Newport News, Virginia

For more data on advertised products, use Readers' Service Cards, last page.

KNOW YOUR FABRICATOR BEFORE YOU BUY

One of a series designed to acquaint you with...

NOOTER

COMPLETE ACID PLANT

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...the final step in giving you a complete job!

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NOOTER CORPORATION

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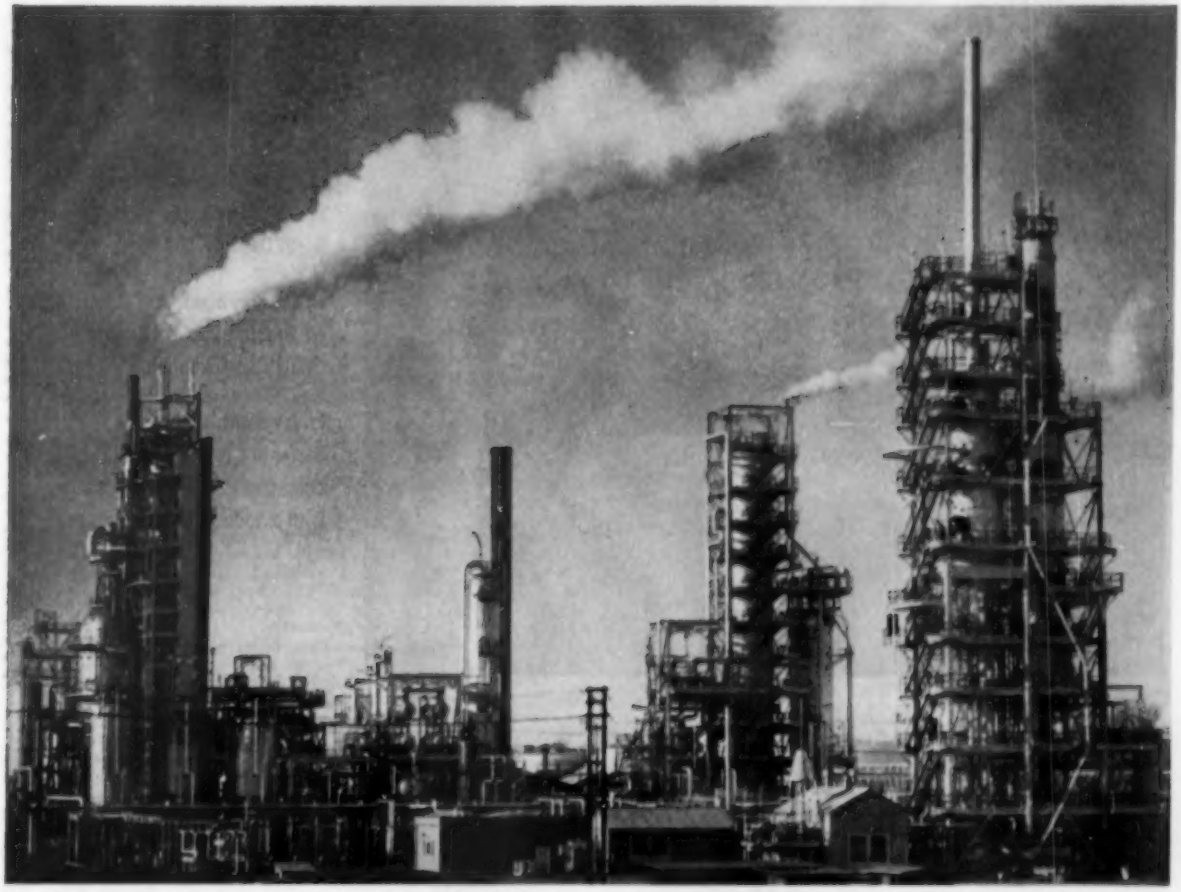
Steel and Alloy Plate Fabricators and Erectors . . . "Boilermakers"

CONSTRUCTION BOXSCORE starts on page 207



New fluid coker at Billings.

First Fluid Coking Unit Goes into Operation

. . . Carter completes new 3800-barrel-a-day unit; starts Montana operation.

THE FIRST commercial fluid coking unit ever built has been dedicated by The Carter Oil Company at its refinery in Billings, Mont. Principal speaker at the ceremonies was Hines H. Baker, president of The Humble Oil & Refining Company.

The new process will increase the plant's gasoline output by about 2350 barrels a day. In addition to refining gasolines and heating oils from residuals and heavy crudes, the unit will produce petroleum coke.

Two other fluid cokers are under construction for another Standard Oil Company (New Jersey) affiliate. Esso Standard Oil Company is building a 20,000-barrel-a-day unit at its Baton Rouge, La., refinery, with another going in for 10,000 barrels a day at its plant in Baltimore.

The Fluor Corporation, Ltd., performed the mechanical design, engineering and construction for the Carter unit, in accordance with Esso Research & Engineering Company's design specifications. The new coker's design capacity is 3800 barrels of fresh feed a stream day.

The coking unit produces its own fuel, consuming 40 tons of the new

Tuesday night, September 28th: the Lummus initial operating team first fed oil into the crude unit of the 30,000 B/D refinery which Lummus designed, engineered and constructed for a major oil company at Mandan, North Dakota.

Wednesday night, September 29th: oil was fed into the fluid catalytic cracking unit.

Friday night, October 1st: the entire refinery was in operation at two-thirds capacity, with products going to storage.

Mandan refinery starts up in three days

The Mandan refinery was completed ahead of schedule, started up in record time, and has been operating ever since. It is an integrated plant including crude distillation section, fluid catalytic cracking unit, vapor recovery section, polymerization unit, treating and blending sections and desalter.

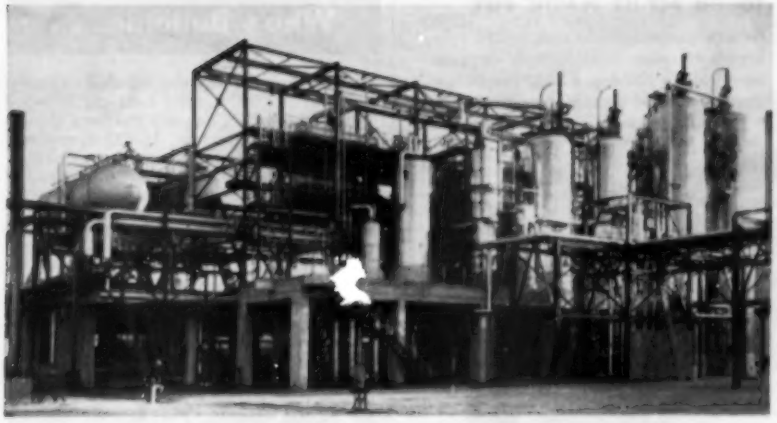
The owner has expressed pleasure and enthusiasm over the excellent time and performance records on the installation, made possible through painstaking engineering and construction efforts.

This adds one more to the over 700 efficiently engineered and constructed projects which Lummus has brought to completion over the past 50 years. May we work with you on your next project.

The Lummus Company, 385 Madison Avenue, New York 17, N. Y. **Engineering & Sales Offices:** New York, Houston, Montreal, London, Paris, The Hague. **Sales Offices:** Chicago, Caracas. **Heat Exchanger Plant:** Honesdale, Pa. **Fabricated Piping Plant:** East Chicago, Indiana.

LUMMUS

DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES



Dutch Unit Goes in Operation—

One of the world's largest deasphalting and decarbonizing units, designed for a maximum oil charge of 12,000 barrels a day and a propane circulation rate of close to 100,000 barrels a day, has gone into operation at the Pernis, Holland, refinery of N. V. de Bataafsche Petroleum Maatschappij, a member of the Royal Dutch Shell group, for producing lubricating oil base stock and catalytic cracking unit feed stock.

oil coke a day. The additional 160 tons of coke produced a day will be available for use in the aluminum and metallurgical industries.

Important advantages of the fluid coking technique not realized in previous coking processes are its continuous operation, without period shutdowns for decoking, and its flexibility of feed stock. Feed having API gravities as low as zero may be processed.

Essentially, the process is an economic method of converting low-value heavy fuel oil, or heavy crude oil, into light oil products, with only a little coke left as a by-product and no heavy oil. When used as feeder stock in the fluid coker, the value of residuals is upgraded to approximately that of crude.

Other interest in the technique has been found among Mid-Continent refiners, faced with a chronic residual oversupply; on the Pacific Coast, which is long on heavy crude, and in the Mid-West, where residual markets are shrinking.

The process is an adaptation of the fluidized solids technique originally perfected for catalytic cracking. Briefly, here is how the Carter unit works:

Heavy residual fractions of crude are injected into a fluidized stream of fine hot coke particles and almost completely converted into over-head vapor and coke. The coke deposits on the hot particles already in the fluidization bed, and partly is removed as a by-product and partly used to re-fuel the system.

The over-head vapor is removed to conventional separation equipment and separated into light oil products, some of which are withdrawn for further processing.

The new technique has at least two important economic implications:

- To oil producers, it offers the first attractive method of refining reserves of low-value, heavy crudes, such as exist in West Texas, California and Canada. Some of these crudes have such high yields as to be almost unmarketable today.
- To refiners, it offers a better total income on each barrel of crude refined. Residual fuel is currently a by-product, with its rate of production determined by the volume of crude needed to meet light product demand, not by market demand for residual itself.

Planned and Projected:

Purafina Italiana, S. p. A., wholly-owned subsidiary of Petrofina, Belgian refiner, will build a 1000-barrel-a-day platformer at its refinery in Genoa, Italy. The unit is scheduled for completion during Spring, 1956.

The company also is building a two-stage distribution unit at its Milan refinery.

Who's Building. . .

Companhia Brazileira de Estireno, organized by Koppers Company, Inc., The Firestone Tire & Rubber Company and certain Brazilian interests, is clearing ground to build a styrene monomer plant at Cubatao, Brazil, capable of producing 10 million pounds a year.

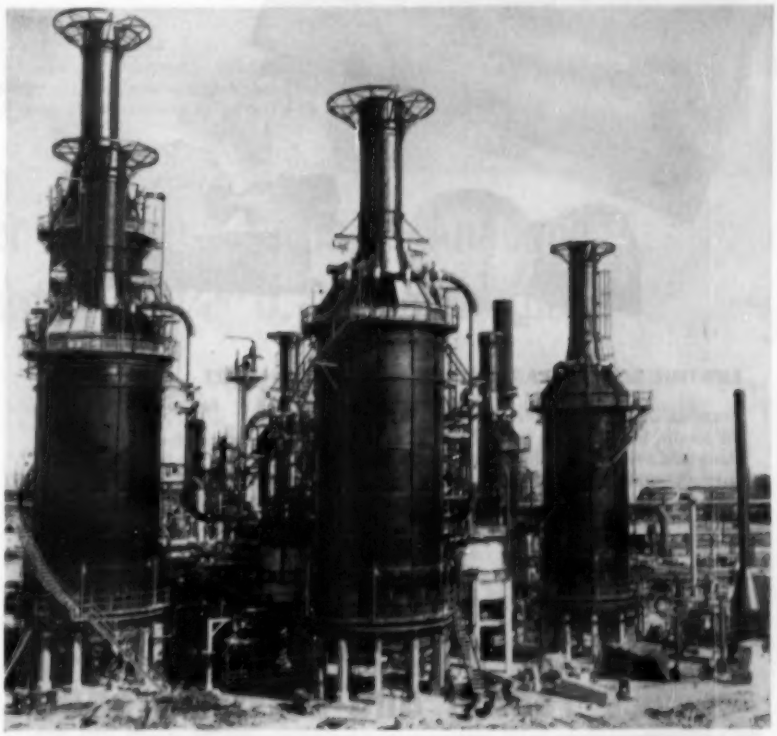
The newly-formed Brazilian firm has been granted a $2.5-million loan by the Export-Import bank to apply on U. S. dollar costs involved in the project.

Standard Oil Company of British Columbia has scheduled a $2.5-million expansion program for its Stanovan refinery at Vancouver. The program, which will include the installation of a new catalytic reformer, is expected to increase throuput by about 25 percent, giving the company an 18,000-barrel-a-day plant. Construction is scheduled for completion late in 1955.

The Greek Government will build the country's first refinery at Aspropyrgos, near Athens. The refinery, due for completion early in 1957, will be built for a daily crude capacity of 30,000 barrels.

Babcock & Wilcox Company will build a plant to make fuel elements for the atomic-power industry about five miles east of Lynchburg, Va., on the James River.

Standard Oil Company (Indiana) will begin construction on its largest crude oil distillation unit at the refinery in Whiting, Ind. The new equipment, designed for a daily capacity of 55,000 barrels, is

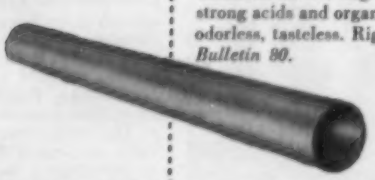


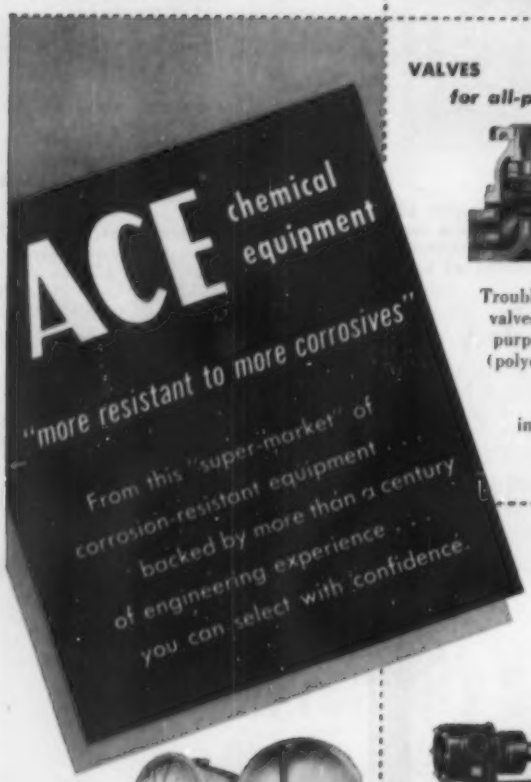
World's Largest Ultraformer Completed—

Pan American Refining Corporation completed its new ultraforming unit at Texas City, Texas, with a daily capacity of 21,000 barrels. The largest such unit ever built, the ultraformer uses a catalyst containing more than 200,000 pounds of platinum.

TOUGH ACE-ITE PLASTIC PIPE

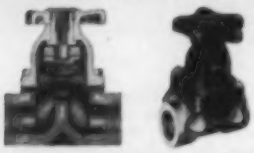
General-purpose moderately priced rubber-plastic pipe handles most common chemicals to 170 deg. F. . . . except few strong acids and organic solvents. Tough, odorless, tasteless. Rigid pipe ½" to 6". *Bulletin 80.*



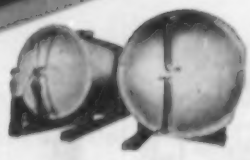

ACE chemical equipment
"more resistant to more corrosives"
From this "super-market" of corrosion-resistant equipment backed by more than a century of engineering experience . . . you can select with confidence.

VALVES

for all-plastic piping systems



Trouble-free plastic diaphragm valves . . . choice of general-purpose ACE-ITE, ACE PARIAN (polyethylene) or ACE SARAN. Handles most corrosive chemicals and food ingredients. Sizes ½" to 2", 50 psi. at 77 deg. F. *Bulletins 80 and 351.*



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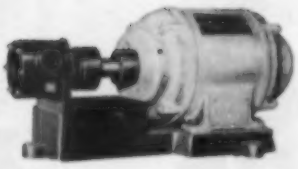
Economical, universal protection against all alkalis, metallic salts, practically all inorganic acids, hydrochloric acid any strength, sulphuric to 50%, nitric to 20%, phosphoric to 75%. Good to 160 deg. F. . . . sometimes higher. Soft rubber interlayer aids shock resistance.



MIGHTY MIDGET

for pumping acids

Jabsco neoprene-impeller pump made of ACE hard rubber out-lasts, out-pumps anything in its pressure, size and price class. Capacity from 15 gpm. at 22 ft. head to 5 gpm. at 72 ft. head. *Ask for free Bulletin 97.*

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AMERICAN HARD RUBBER COMPANY

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Who's Building . . .

expected to increase the refining capacity to about 220,000 barrels a day in 1956.

C. F. Braun & Company has been named as primary contractor. Initial operations are scheduled to begin in January, 1956.

Heat need for the distillation process will be supplied by three new furnaces. Heat absorbed on the twin heaters for primary distillation will be 117 million British thermal units an hour, and on the heater for the vacuum distillation will be an additional 25.5 million Btu an hour.

Electrostatic desalting equipment will be included with the new unit.

Other construction underway at the 212,000-barrel-a-day Whiting refinery includes a fluid hydroformer, due to be completed this spring with a daily capacity for 27,000 barrels. The M. W. Kellogg Company is in charge of building the unit. The company also plans to modernize its motor oil facilities.

Tide Water Associated Oil Company will erect its $100-million East-Coast refinery at Delaware City, Del., near Wilmington. The new plant will replace the company's refinery at Bayonne, N. J., where operations gradually are being reduced.

Scheduled for completion in late 1956, the new 130,000-barrel-a-day refinery will be the largest ever built from the ground up. Three of the process units will be the biggest ever designed.

In addition to the world's largest crude unit, the refinery will include the biggest catalytic cracking unit, an Orthoflow unit with a total charge capacity of 102,000 barrels a day. A fluid coker, to be built for a daily capacity of 42,000 barrels, also will be the largest such unit ever built.

Other refining units will include a catalytic hydrodesulfurization unit, together with a catalytic reforming unit, a polymerization unit, an alkylation unit and a sulphur-recovery unit.

The refinery will circulate 10 million barrels of cooling water a day. It will be served by a 50,000-kilowatt power plant with a steam-generating capacity for 1.5 million pounds an hour.

Tide Water will locate its refinery on a 4200-acre site fronting on the Delaware River. The site was selected because it offers:

- Deep-water shipping lanes, rail lines and highways, permitting fast distribution to the company's eastern market area.
- Solid land adjacent to a channel which can be dredged to depths suitable for tankers.
- Ample room for expansion.

Present plans call for the erection of tankage with a capacity for about 7 million barrels of crude oil and petroleum products.

Initial work on the site includes dredging a four-mile-long channel, with the materials removed to be used to build up the shore area. A marine terminal will be constructed at the refinery.

The Delaware project is part of the company's long-range expansion program. The program is expected to require a capital outlay of $127 million in 1955.

American Oil Company will build a 35,000-barrel-a-day refinery near Yorktown, Va., to augment gasoline production at its 145,000-barrel-a-day refinery in Texas City, Texas. The new plant, the

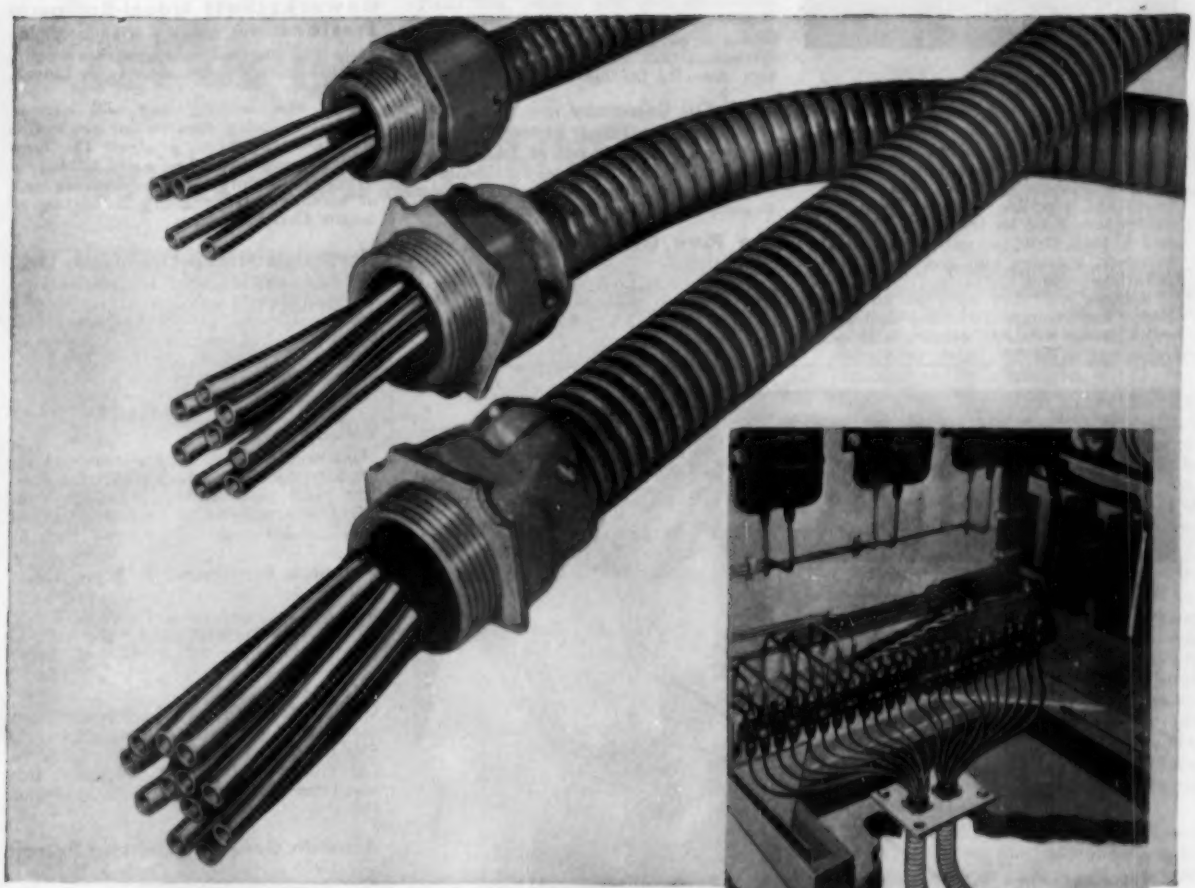

PHOTO above shows 4-, 8- and 12-tube ARMORTUBE cable. Drawing at right shows the application of Bailey ARMORTUBE cable for making connections to a Control Panel.

TO MAKE ARMORTUBE CABLE . . .

Bailey Meter Company turns to Anaconda for long lengths of ¼" O. D. copper tubes

Bailey Meter Co., Cleveland, Ohio, calls its ARMORTUBE Flexible Protected Tube Cable, "the modern shortcut to simpler, safer, more economical air and hydraulic circuits."

As shown above, this cable is available in bundles of four, eight or twelve ¼" O.D. copper tubes. A continuous, heavy galvanized steel strip protects the tube bundle.

Here's why Bailey turned to Anaconda as the logical source of supply for these ¼" O.D. copper tubes.

LONG LENGTHS

because ARMORTUBE cable is shipped in random lengths of about 500 feet, Bailey needed long lengths of copper tube. Anaconda makes copper tube up to 2,400 feet long, depending on the diameter.

CLEAN INTERIORS

These tubes had to be free from dust, dirt or metal chips which might otherwise interfere with the operation of delicate air and hydraulic circuits. Anaconda takes special care to see that inside surfaces of ANACONDA Copper Tubes are clean, smooth and bright. Tube ends are sealed to keep out moisture and foreign matter during storage.

FLEXIBLE

Tubes had to be flexible enough to bend around corners and obstacles. ANACONDA Copper Tubes are uniformly soft . . . highly flexible. And they are accurate in size and shape.

ANACONDA Dehydrated Copper Tubes are made in all standard sizes up to and including ½" O.D. Usually furnished in 25-, 50- and 100-foot coils, they are also available in longer lengths on spools and reels where required.

Our Technical Department will be happy to lend a hand on any problem involving the use of copper tubes. A letter outlining your problem will bring a prompt answer. Write to: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

54158

ANACONDA

COPPER TUBES

For more data on advertised products, use Readers' Service Cards, last page.

Who's Building . . .

first refinery to be built in Virginia, is scheduled for completion by late 1956.

An initial general contract was awarded The M. W. Kellogg Company for construction of two major refining process units, plus three buildings and all electrical and pipe-line facilities. Additional contracts will be let for another building and a tank farm, as well as a catalytic reformer, a coking unit and a gas-oil desulfurization unit.

Kellogg will start work on an atmospheric and vacuum distillation unit and a combination catalytic cracker and polymerization unit. The cracker will charge 30,000 barrels a day, 21,500 barrels fresh feed and 8500 barrels recycle. The polymerization unit will have a daily production capacity for 800 barrels.

Shell Oil Company is to build a new 700,000 sterling (about $1,960,000) lubricating oil blending plant at Island View, near Durban, South Africa. Final plans for the project, which would require two years to complete, have not been drafted.

The Pure Oil Company will build new catalytic reforming units at its refineries in Smiths Bluff, Texas, and Lemont, Ill. The two units will be included in a capital outlay expected to reach $41 million this year.

Gewerkschaft Erdoel-Raffinerie Emsland will install a Houdriforming unit, including a Houdry guard case pretreating section, at its refinery in Lingen, Germany.

The new refining unit will have a 3500-barrel-a-day capacity for production of high-octane motor gasoline. The Emsland refinery now has a 17,500-barrel-a-day Houdriflow catalytic cracking unit in operation, processing a mixture of nearby German crudes.

Northwest Nitro-Chemicals, Ltd., has completed financial arrangements for an ammonia and ammonia-nitrate plant in Alberta, Canada. Owned by New British Dominion Oil Company and Commercial Solvents Corporation, the plant will use a Commercial Solvents process in its ammonia-nitrate operations.

Turkey is considering construction of a plant near Istanbul to process natural gas recently discovered in the Murefte area. The plant probably would include a refinery and possibly to process crude oil which, it is hoped, will be found there.

Petroleo Brasileiro, S. A., will start construction on an asphalt plant and crude terminal facilities at its Cubatao, Brazil, refinery. The new plant will be built to charge 3500 barrels a day of heavy crude oil.

Utah Oil Refining Company plans to build an ultraformer at its refinery in Salt Lake City. The company, a Standard Oil Company (Indiana) affiliate, has scheduled construction on the unit to start this year.

Azienda Generale Italiana Petroli will build a refinery at Cagliari, Sardinia, to develop the bunkering business. The new plant is expected to have a yearly capacity for 13.5 million barrels.

Standard-Vacuum Oil Company is studying plans for construction of a refinery near Manila, in the Philippines. The announcement was made by H. F. Prioleau, president.

Prioleau was in Tokyo, Japan, where he spent a few days with M. J. Rathbone, president of Standard Oil Company (New Jersey), and G. S. Dunham, a director of Socony-Vacuum Oil Company.

The party was en route to Melbourne, Australia, where Standard-Vacuum Refining Company, Ltd., is nearing completion on a $30-million refinery. The plant will be opened with a daily capacity of 25,000 barrels. (See Page 207.)

Indian Government is planning Asia's first synthetic petroleum plant. Plans have been approved in principle to build a 6000 barrel-a-day plant to produce about 10 percent of the country's requirements. Output would be divided into 4300 barrels a day of motor gasoline and 1700 barrels of aviation fuel.

Frontier Oil Company has narrowed its choice of sites for a Florida refinery to Fort Pierce after considering several locations in the state. The proposed 15,000-barrel-a-day plant will cost $16 million.

Great Plains Refinery Company will build South Dakota's first refinery at Rapid City. The plant, to be built for a daily crude capacity of 3000 barrels, will

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SIMPLE • RIGID • NO LOSS OF FLUID

Here, in the Robinson Rigid Duplex Line Blind Valve, you are assured a positively leak-proof line shutoff, easy to operate. No spreading of lines or loss of fluid. Available as an orifice fitting.

The "O" rings, inserted in dove-tailed grooves of the flow controlling member provide a positive seal against any possible leaks. Pressure from the flowbore exerts itself against the "O" ring, making an ideal leak-proof seal.

Extremely simple in design with very few parts, no gears, sleeves or special packings other than the two "O" rings, this rugged line blind valve is available in sizes from 2" to 16", from 150# to 1,500# ASA. Insist on Robinson and be SAFE.

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You'll find the Robinson ECON-O-BLIND an excellent answer to positive shutoff problems. It is a rigid type blind and the most economical on the market today. The ECON-O-BLIND incorporates the Robinson replaceable "O" ring seal and is available in sizes 2" to 16", 150# to 600# ASA.

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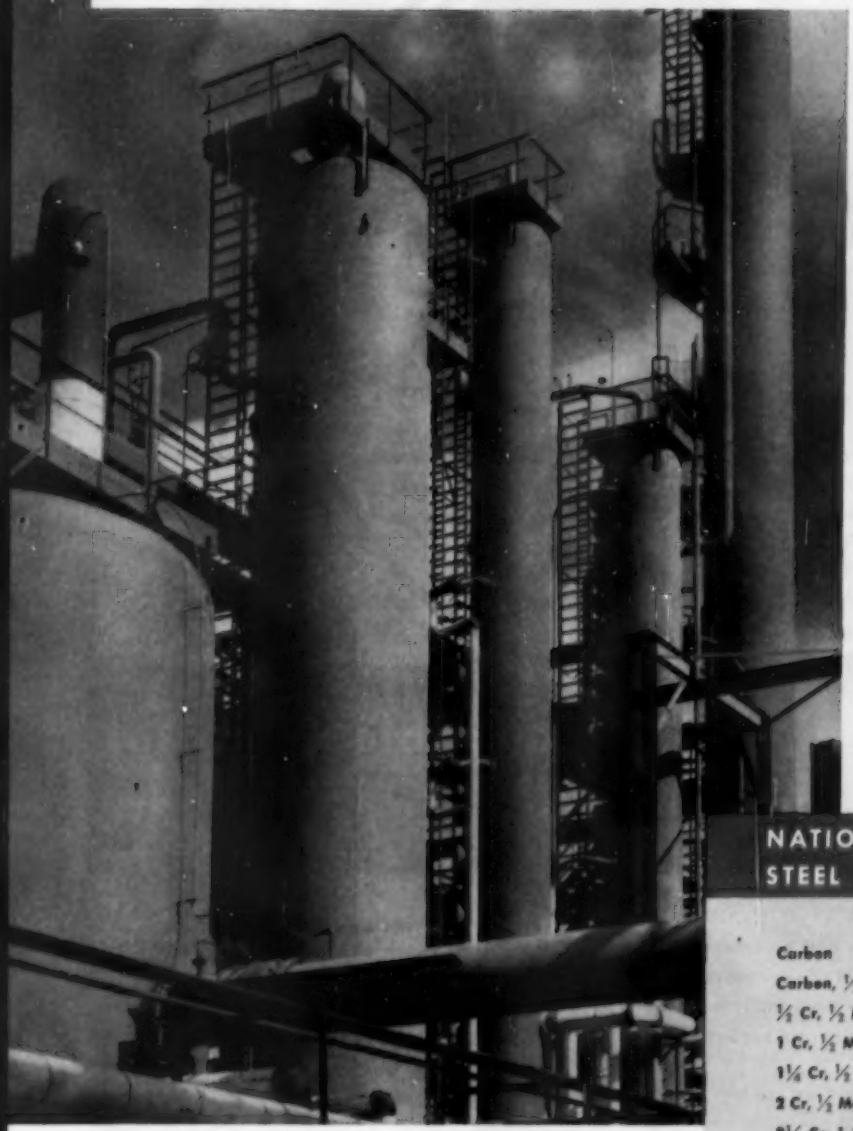

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Certainly there are a lot of things to consider when you're selecting refinery pipe or tubing—basic differences in equipment, for instance, or variations in fabricating operations, required service pressures, presence of corrosive media, and many other factors which will determine the steel analysis you must use.

For over 60 years, National Tube has maintained a file of case histories on refinery tubing problems—and we've come up against just about all of them. Using this experience file, our engineers have developed 25 different steel tube analyses—each for combatting specific refinery conditions. Other chemical compositions are also available in tubular products, and a wide variety of high temperature problems are now under study. These analyses are at your disposal.

Look over the list shown here. Then before you choose your new pipe or tubing, consult our engineers to be certain that you get the right analysis—the one that will do the best job at the lowest cost. Write to: National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

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Carbon	5 Cr, ½ Mo	18-8
Carbon, ½ Mo	5 Cr, ½ Mo, 1½ Si	18-8 Ti
½ Cr, ½ Mo	7 Cr, ½ Mo	18-8 Cb
1 Cr, ½ Mo	8 Cr, ½ Mo	18-8 Mo
1¼ Cr, ½ Mo	8 Cr, 1 Mo	25-20
2 Cr, ½ Mo	9 Cr, 1 Mo	3½ Ni
2¼ Cr, 1 Mo	12 Cr	5 Ni
2½ Cr, ½ Mo, ¾ Si	12 Cr, Al	
3 Cr, 1 Mo	17 Cr	

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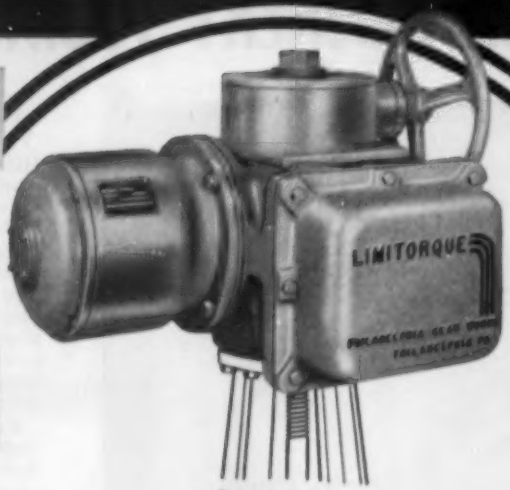
new Limitorque economy...

greater valve stem capacity

gives more torque



withstands greater thrust

compact and simple

features

Two piece stem nut design permits changing unit from one valve to another. Torque control for both directions of stem travel or single direction as required. Easier handwheel operation. Improved switch design and electrical arrangement. Either torque or geared limit control operation. Easier declutching.

no complicated gear drives

minimum friction losses

most economical and dependable operator for all small valves.

Do you have need for a small, low cost automatic valve operator that will give you rapid operation control of your valves? If so, the SMA-00 and SMA-000 is the answer. They are readily adaptable to all types of valves, including gate, plug, globe and butterfly.

Size for size these units are designed for greater valve stem capacity, will produce more stem torque, and will withstand greater thrust than any other valve operator on the market. Also, should a power failure occur, LimiTorque can be operated by the hand wheel.

It will pay you to secure full details regarding this exclusive, accurate and powerful small valve operator. We suggest that you send for new LimiTorque Bulletin 1A-54 which illustrates and describes the construction and operation of these little giants.

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LimiTorque Corporation Philadelphia

Industrial Gears & Speed Reducers

LimiTorque Valve Controls

Established 1892

Who's Building . . .

cost about $3.1 million.

Construction will be handled by Succop Refinery Engineering Company. Process equipment will include crude, vacuum and cracking units, plus a poly plant. Completion is scheduled for late this year.

Standard Oil Company (Indiana) is planning to add a 6000-barrel-a-day Ultraforming unit and other new facilities at its refinery completed last October at Mandan, N. D. Construction on the Ultraformer is expected to start this summer, with completion and initial operations planned for late next spring.

Canadian Hydrocarbons, Ltd., plans an ammonia plant near Winnipeg, Manitoba. Recently formed by a group of U. S. and Canadian investors, including Winnipeg & Central Gas Company, the new company will go into the L. P. G. and petrochemical business.

Chemische Werke Huels, A. G., is considering a $24-million synthetic-rubber plant in Germany. The plant would be built for an annual capacity of 30,000 tons.

The company, formerly part of the I. G. Farben interests, produces synthetic rubber on a relatively small scale, having the only production in West Germany.

Standard Oil Company (Indiana) will begin construction of a pilot plant for solid rocket propellants at Seymour, Ind. The company has been doing research on rocket propellants at its Whiting, Ind., laboratories since 1951.

Republic of Korea is considering construction of a $25-million urea fertilizer plant. With an annual capacity for 80,000 tons, the plant would use fuel oil as a source of ammonia. F. H. McGraw & Company and Hydrocarbon Research, Inc., are negotiating a contract to build the plant. Plans call for completion during the summer of 1957.

Shell Oil Company of Canada will build a $1.5-million platformer at its refinery in Vancouver, B. C. The new unit is scheduled for completion by the end of 1955. It will be able to process 3300 barrels of feed stock a day. The new improvement follows a $10-million expansion program completed at the refinery in 1954.

Standard Oil Company of California will spend $16 million in building an ammonia and fertilizer plant at Richmond, Calif. The ammonia plant, to be built for a daily capacity of 300 tons, will produce both ammonia and nitric acid.

Part of the output will go to the new fertilizer plant, being built by California Spray-Chemical Corporation, a Standard subsidiary.

The anhydrous ammonia plant will derive hydrogen from catalytic reformers at the company's Richmond refinery. California Standard has been operating a 13,750-barrel-a-day fixed-bed Hydroformer since the war, and is building a Platformer for a daily capacity of 20,000 barrels.

Idemitsu Kosan Company plans to build a new Japanese refinery at the former naval-fuel depot in Tokuyama, Shikoku. If the government approves the firm's application to purchase its depot, construction will be started on a plant with a daily

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"50"
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ANNUNCIATOR
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LOOK inside the new Universal PANALARM "50". You will realize that here, at last, is an annunciator system built for long term dependability and service. Built to match the responsibility an annunciator must assume in your plant.
The PANALARM "50" Cabinet has a substantial hinged door . . . with sub-door to allow easy access to signal lamps. It has a new, rugged chassis design . . . pre-wired to handle any standard audio-visual signal requirement . . . and so flexible that signal sequences can be changed by simple terminal connections. No re-wiring is needed.
All moving parts and contacts of the PANALARM "50" are within hermetically sealed, plug-in units. They are corrosion-proof and suitable for Class I, Div. 2 locations. All connections are made to a single terminal block . . . with ample space for wiring.
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New WATSON-STILLMAN
150 LB. STAINLESS STEEL
PIPE FITTINGS, *Types 304, 316*

Now you can get performance-proved Watson-Stillman Fittings for standard pressure services that need the corrosion resistance, heat resistance and low temperature toughness of 18-8 Stainless Steel.

W-S 150 lb. Stainless Fittings, rated at 400 psi cold non-shock working pressure and 150 psi steam pressure, are ideal for process piping, refrigeration systems, high temperature liquid and gas piping and other piping systems. They are available in both Screw-End and Socket-Welding Types in sizes ⅛" to 2".

The new Watson-Stillman Stainless Steel Fittings will assure you of long, trouble-free service in tough piping applications... will reduce down-time and cut maintenance costs. For full technical information on these fittings write today for Bulletin S-3-55.

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WATSON-STILLMAN FITTINGS DIVISION
H. K. PORTER COMPANY, INC.
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10

Who's Building...

crude capacity of 18,000 barrels.

Part of the cost of building the 4500 million yen plant will be furnished by National Iranian Oil Company, which also has agreed to supply the crude oil. The Iranian company would accumulate in Japan half the proceeds from the sales of oil to Japan, with part of the reserves to be lent to help construct the refinery.

Refineria de Petroleos de Escombreras, Spanish affiliate of California-Texas Oil Company, has completed a lubricating oil plant at its refinery in Escombreras. Foster Wheeler Corporation was in charge of engineering and construction on the plant, built to produce 27,500 tons a year.

Esso Petroleum Company, Ltd., has started construction on a $28-million expansion of its refinery at Fawley, England.

Additional equipment will permit the company to turn more of its production at the 146,000-barrel-a-day plant into heavy fuel oil. Present output of fuel oil at Fawley is about 35,000 barrels a day.

Yugoslavia has drawn up plans to build a large oil refinery at Makarska. Foreign exchange has been granted on the purchase of essential equipment in France.

Under Construction

Husky Oil & Refining, Ltd., has work underway for expanding and modernizing its recently-acquired refineries at Moose Jaw, Sask., and Fort William, Ont. Both projects are scheduled for completion July 1, 1955.

At its Lloydminister, Alba., refinery, Husky is completing a $1-million program, raising capacity at that plant to 8500 barrels a day.

More than $1 million will be spent at the Fort William plant, where the daily capacity is to be raised from 1800 to 5000 barrels. The Moose Jaw refinery's present 2000-barrel capacity will be increased to 5000 barrels a day.

New installations at Fort William include a platforming unit, a diesel desulfurization unit and a new asphalt plant. Contracts have been let to Horton Steel Company for construction of additional storage tanks. The Fluor Corporation of Canada, Ltd., will erect the new processing equipment.

Plant extension is in progress at Moose Jaw, with Fluor also building new catforming and desulfurization units there, as well as a vacuum distillation unit, a vis-breaker, towers and a crude oil furnace.

The Standard Oil Company of Ohio is building a $17-million petrochemical plant at Lima, Ohio. The plant, utilizing refinery and natural gases as raw materials, will further diversify the company's operations, with the manufacture of fertilizers and other petrochemicals scheduled to start early in 1956.

The plant will have a daily capacity for 300 tons of anhydrous ammonia, of which 200 tons will undergo further processing to make 125 tons of urea, 60 tons of nitric acid and more than 200 tons of nitrogen solutions. The products will be used as fertilizers and in the manufacture of plastics and other industrial materials.

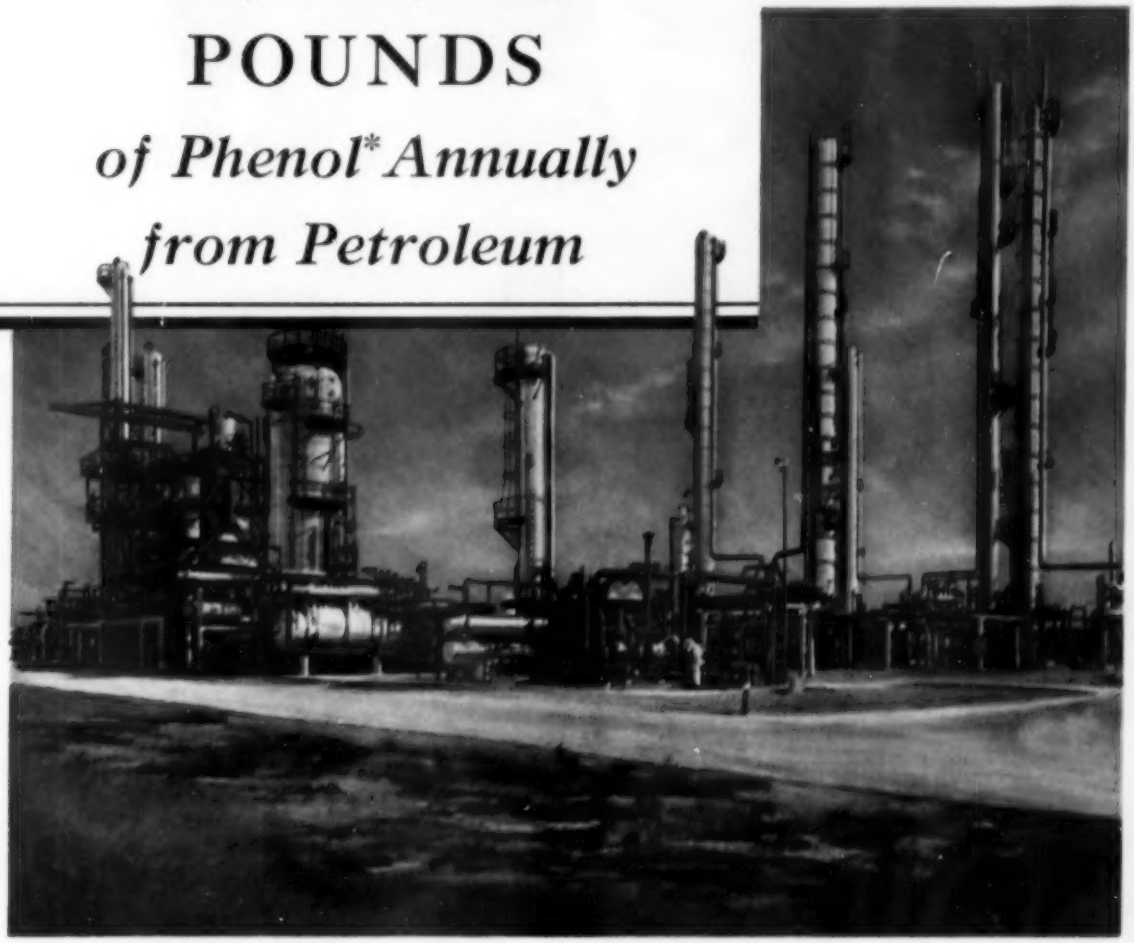
Valley Gas Corporation has started construction on a new natural gasoline plant in New Mexico's Anderson Ranch

For more data on advertised products, use Readers' Service Cards, last page.

40,000,000 POUNDS

of Phenol Annually from Petroleum*

**"Phenol" is one of today's "Big Three" in chemicals—a base material for the expanding plastics industry.*



Standard Oil Company of California now is making pure phenol and acetone from cumene by a new process at its Richmond, California Refinery under license from Hercules Powder Company.

Acting as Process Consultants and Constructors, Stone & Webster Engineering Corporation worked closely with the engineers of Standard Oil, who prepared the process and mechanical designs. The plant was completed ahead of schedule and operated in excess of rated capacity.

Write or call us for information as to how our experience may be of assistance to you.

STONE & WEBSTER ENGINEERING CORPORATION

BADGER PROCESS DIVISION

AFFILIATED WITH E. B. BADGER & SONS LIMITED (LONDON)

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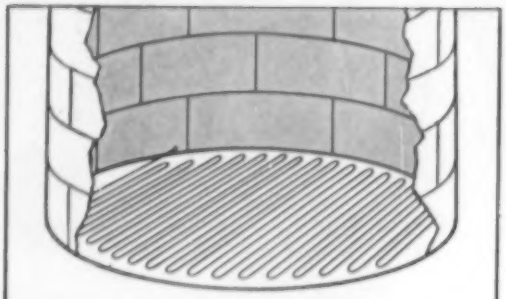
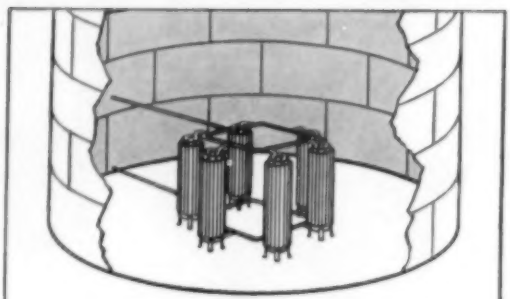
BROWN FINTUBE'S

BETTER DESIGN MEANS BETTER PERFORMANCE



• Old-fashioned coils on the bottom of the tank are expensive to install. The pipes are soon covered over with sediment which seriously restricts the transfer of heat from the pipes to the tank liquid. The tank bottom is cluttered and difficult to clean.



• Our TF-18 Tank Heaters mount vertically. Sediment can not settle on the heat transfer surfaces. Heaters are entirely surrounded by tank liquid, assuring highly efficient heating of stored products year after year. Tank bottom is uncluttered, easy to clean.

Vertical Mounting

of BROWN FINTUBE TF-18 TANK HEATERS

assures more efficient, less costly heating of stored products

Our TF-18 vertically mounted tank heaters have obsoleted old-fashioned tank coils — and give users four outstanding advantages:—

1) **Lower Cost**—Users report that the cost of our TF-18 Heaters *plus* their installation is usually ***less than the cost of just installing*** bare pipe coils of equivalent capacity.

2) **Vertical Mounting** — on legs about 10" above the tank floor brings the entire heating surface in contact with the stored product — avoids heating through a layer of sediment.

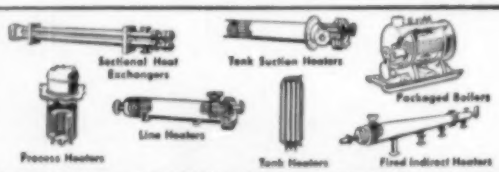
3) **Increased Heating Efficiency** — the finned construction provides about 7 times more heating surface per foot of lineal length than plain bare pipe. This permits more heat to be transferred — faster — at lower temperatures per square foot of surface, avoiding coking or damage to heat sensitive products. Mild steel or alloy construction.

4) **Easy Installation** — TF-18 Heaters pass through a standard manhole permitting easy installation in new or existing tanks. Can be flange connected when desired and thus do not require welding inside the tank. Individually trapped, or manifolded inside or outside the tank.

You can't keep your operations competitive with old-fashioned, obsolete methods. Write today for Bulletin 541. It gives full details, dimensions, etc., about our fully proved, less costly TF-18 Heaters. Tested, and widely used by many of the best known, most progressive, lowest cost companies in the industry. Write for Bul. No. 541 ***today!***

BROWN FINTUBE CO.

370 HURON ST., *Elyria, Ohio*



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Who's Building . . .

field in Lea County.

The plant will process up to 5 Mmcf of gas a day and at capacity will produce 50,000 gallons of propane and heavier mixtures. The product will be moved by pipeline to the company's plant in Eddy County to be fractionated.

Completions:

Mediterranean Refining Company has completed its new 6250-barrel-a-day refinery at Sidon, Lebanon. Owned jointly by California-Texas Corporation and Socony Vacuum Overseas Supply Company, the refinery is near Beirut, on the Mediterranean.

Construction began more than two years ago with a refinery capacity originally set at 6250 barrels a day. Planning is underway, however, to expand daily thruput to 9000 barrels by 1956.

Monsanto Chemical Company has started production at its new polyethylene plant in Texas City, Texas. The plant, built for the company's Plastics division, will produce at capacity 66 million pounds a year.

The Humble Oil & Refining, Gulf Refining and The Texas companies have started operations at a new jointly-owned $7.5-million natural gas recycling plant at Krotz Springs, La., near Baton Rouge. The plant, due for completion in June, now is processing up to 70 million cubic feet of gas a day now and will handle 100 million when completed.

Union Oil Company of California has scheduled its sixth refinery for completion this month at Santa Maria, Calif. Built for a daily capacity of 18,700 barrels, the $16,475,000 plant includes a 42-ton-a-day sulfur plant.

Danaho Refining Company has put a new platformer on steam at its Pettus, Texas, refinery, marking completion of the first phase of an expansion program intended to increase the plant's daily crude capacity from 4000 barrels to more than 10,000.

The catalytic reforming unit, employing a platinum catalyst, is averaging 1000 barrels a day at present. Manufacture of premium-grade gasoline with this equipment is replacing a large part of production formerly devoted to jet fuel.

Petroles Mexicos has dedicated its new lubricating oil and wax facilities at the A. M. Amor refinery at Salamanca, in Guanajuato.

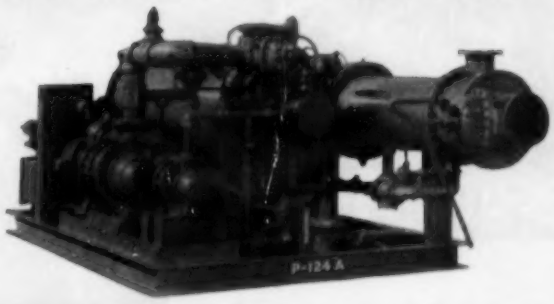
Built at a cost of 310 million pesos (about $25 million), the new plant is expected to furnish Mexico a domestic supply of lubricants valued at $15 million a year. Processes selected for the new plant include vacuum distillation, propane desalting, furfural refining, solvent dewaxing of the lube oil stocks and fractionation of wax, clay treating, and blending.

Black Thunder Oil Company has completed its new natural gasoline plant in Wyoming's Clareton oil field. The plant, located near Newcastle, was built for a daily capacity of 5 Mmcf of natural gas.

The company plans to build another plant as soon as a site is selected. The

The upper unit illustrated is a portable R-C Inert Gas Generator, oil-fired, with capacity of 35,000 cfh. The lower unit is a stationary type, gas-fired, with capacity of 50,000 cfh.

PROTECTION
at your finger tips
with
R-C INERT GAS GENERATORS



CHECK THE R-C
"BIG 4"
ESSENTIALS

1. Compact units, portable or stationary
2. Choice of gas or liquid fuels
3. Low cost per cubic foot of capacity
4. Little supervision or maintenance

You can find this combination of values only in R-C Inert Gas Generators.

Quick availability of smothering inert gas to reduce fire or explosion hazards not only protects against accident or property damage, but frequently results in lower insurance costs which often repay the cost of the equipment.

With R-C Inert Gas Generators, you can get fast action from either stationary or portable units. They can operate on either gas or liquid fuel, and their simple design permits instant readiness with little attention.

ASK FOR DETAILS

Ask the R-C engineer to point out where Inert Gas Generators can be used to advantage in your plant. Or, write for Bulletin 100-B-14.

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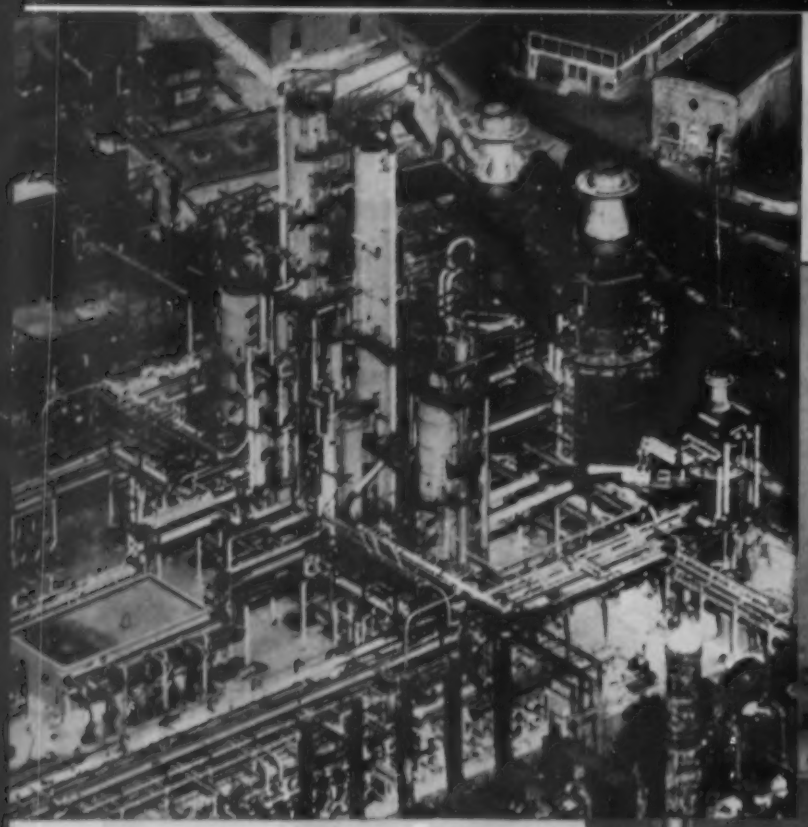
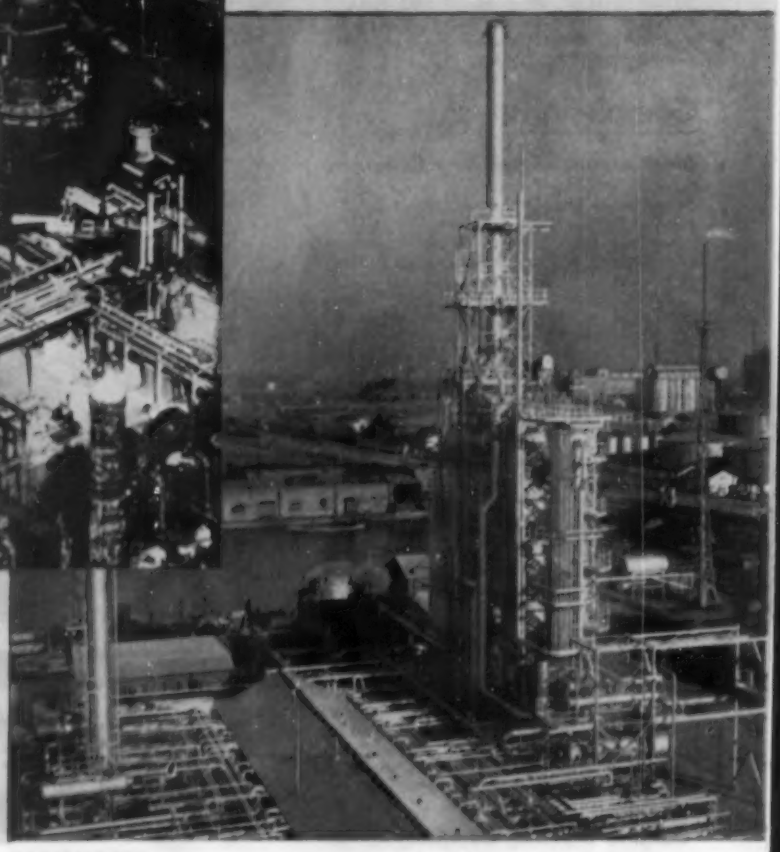
Centrifugal and Rotary Positive Blowers and Exhausters • Positive Displacement Meters • Vacuum Pumps • Gas Pumps • Inert Gas Generators • Spiroaxial Compressors



RIGHT IN OUR OWN BACK YARD

OHIO



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JAPAN

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Stanvac Cat Cracker Goes on Stream—

The first refinery in Australia to produce gasoline by catalytic cracking has been opened at Altona, near Melbourne. Built for Standard-Vacuum Refining Company, Ltd., the 25,000-barrel-a-day refinery will provide more than 16 percent of the Commonwealth's petroleum demands and 20 percent of its gasoline requirements. Stanvac has operated a 2000-barrel-a-day lube oil and asphalt plant at Altona since 1949, but the 12-fold expansion makes the refinery virtually a new plant. Still to be completed are a 1600-barrel-a-day alkylation unit and a catalytic reformer.

Who's Building . . .

newer unit would have a capacity similar to the $400,000 plant completed near Newcastle.

Imperial Chemical Industries, Ltd., has gone into partial production at its terylene plant, nearing completion at Wilton, England.

The first unit completed to produce polyester fiber has an annual capacity for 11 million pounds a year. A second unit, due for completion this year, will double the plant's output.

Spencer Chemical Company has made initial production tests at its new $15-million polyethylene plant at Orange, Texas. During the trial run, the plant was operated at 80 percent capacity.

Quaker Valley Constructors held the contract for building the 45-million-pound-a-year plant. Engineering was handled by Wyatt C. Hedrick Engineering Corporation and members of the Spencer staff.

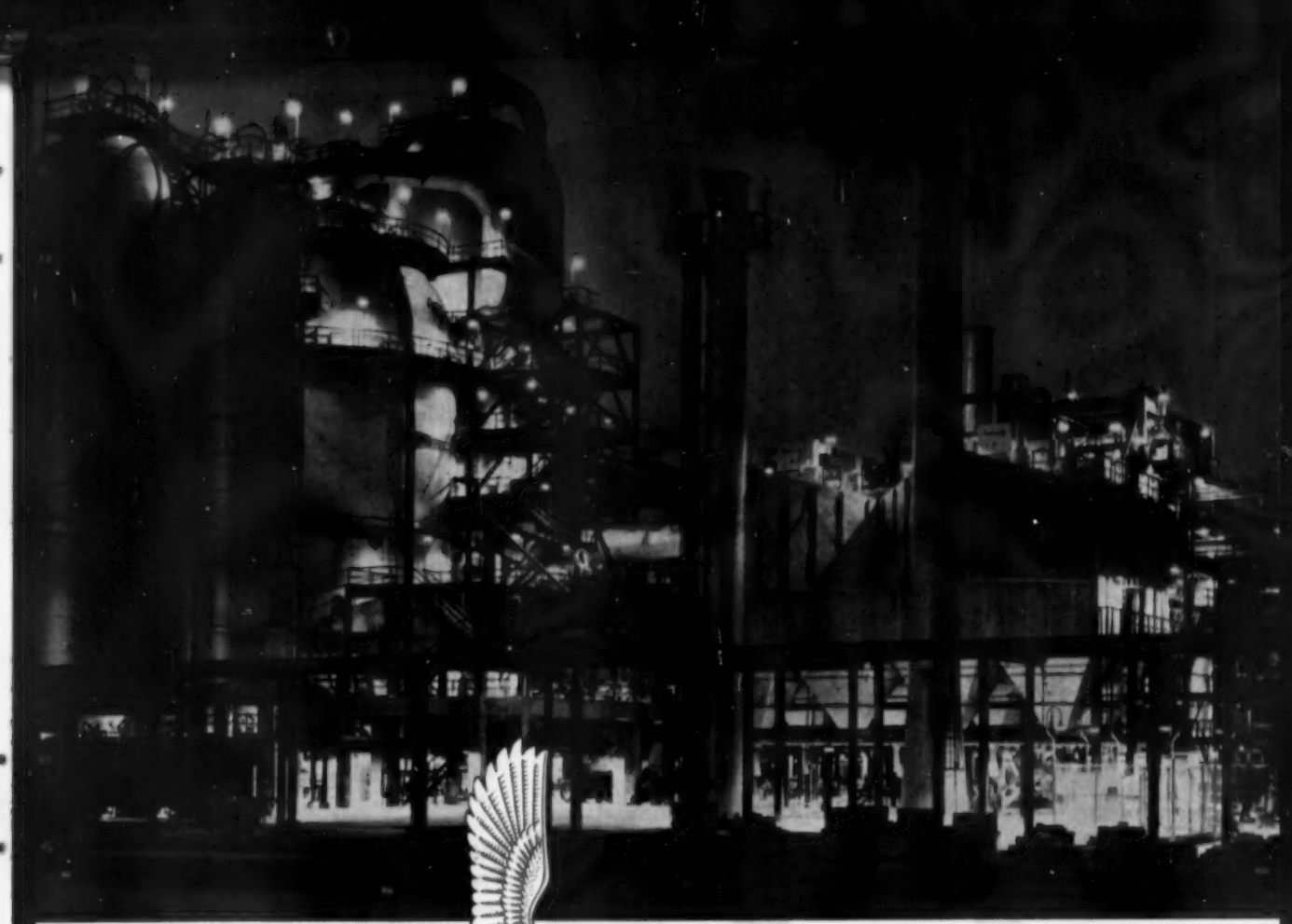
Pan American Refining Corporation has completed a mercaptan synthesis plant at Texas City, Texas. The first unit of its kind to produce methyl mercaptan in large quantities, the 5-million-pound-a-year plant will produce material for organic synthesis of methionine.

Construction Boxscore: Refineries and Other Plants . . .

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
EAST									
Allied Chem. & Dye	Hopewell, Va.	Inc. Ammonia Capacity	50,000 tons/yr.	.....	Complete	.....	.....	Girdler	Girdler
Allied Chem. & Dye	Buffalo, N.Y.	Aromatic Fac.	.....	$6,940,000	PAD Certified	.....	.....	.....	.....
*Allied Chemical & Dye Corp.	Moundsville, W. Va.	Hydrogen & Oxygen Plt.	.....	.....	Engineering	Jan., 1956	.....	Girdler	Girdler
*Allied Chemical & Dye Corp.	Chicago, Ill.	Hydrogen Plt.	.....	.....	Engineering	May, 1956	.....	Girdler	Girdler
American Oil Co.	Yorktown, Va.	Refinery	35,000 bbls.	$25,000,000	Clearing Site	Late, 1956	.....	Kellogg	Kellogg
Ashland Oil & Refining Co.	Catlettsburg, Ky.	Houdriformer	6,000 bbls.	.....	Under Constr.	June, 1955	Houdry	Cat. Constr.	Cat. Constr.
*California Oil Co.	Perth Amboy, N.J.	Crude Desalter	30,000 bbls.	$125,000	ODM Cert.	.....	.....	.....	.....
*Columbia-Southern Chemical Corp.	Natrium, W. Va.	Anhydrous Ammonia Plt.	.....	$3,000,000	Under Constr.	April, 1955	.....	.....	.....
*Du Pont	Belle, W. Va.	Ammonia Plt.	.....	$4,000,000	Under Constr.	.....	.....	.....	.....
*Du Pont	Parlin, N.J.	Polyester Film Base	.....	.....	.....	.....	.....	.....	.....
*Du Pont	Parkersburg, W. Va.	Tetrafluoroethylene Expan.	.....	.....	.....	.....	.....	.....	.....
*Du Pont	Niagara Falls, N.Y.	Adipcnitrile Unit Expans.	.....	.....	.....	.....	.....	.....	.....
Du Pont	Louisville, Ky.	Inc. Fluorinated Hydrocarbon Capacity	.....	.....	Under Constr.	4th Qtr., 1955	.....	.....	.....
*Escambia Bay Chemical Corp.	Pensacola, Fla.	Ammonia, Nitrogenous Fertilizer Plt.	.....	.....	Planning	Early 1956	.....	.....	.....
Esso Standard Oil Co.	Baltimore, Md.	Fixed Bed Hydroformer	3,000 bbls.	.....	Under Constr.	2nd Qtr., 1955	.....	SOD & Contractor	Foster Wheeler
Esso Standard Oil Co.	Baltimore, Md.	Hydrofinishing Equip.	17,000 bbls.	.....	Under Constr.	2nd Qtr., 1955	.....	SOD & Contractor	Foster Wheeler
Esso Standard Oil Co.	Baltimore, Md.	Fluid Coker	10,000 bbls.	.....	Under Constr.	2nd Qtr., 1955	.....	SOD & Contractor	Bechtel
*Esso Standard Oil Co.	Linden, N.J.	Convert Blending Syst. to Semi-Automatic	.....	$2,120,000	ODM Cert.	3rd Qtr., 1955	S.O.D.	S.O.D.	Staff
Esso Standard	Linden, N.J.	Cat. Poly. Plt.	9,100 bbls.	.....	Under Constr.	.....	.....	S.O.D., Braun	Braun
Esso Standard	Everett, Mass.	Asphalt Vacuum Tower	13,100 bbls.	.....	Complete	.....	S.O.D.	S.O.D.	.....
*Esso Standard Oil Co.	Everett, Mass.	Desalters	25,000 bbls.	$612,000	ODM Cert.	4th Qtr., 1955	.....	S.O.D.	Petrolite
*Frontier Refining Co.	Fort Pierce, Fla.	Refinery	15,000 bbls.	$16,000,000	Planning (Unconfirmed)	.....	.....	.....	.....
The Girdler Co.	Louisville, Ky.	Catalyst Plt.	.....	.....	Under Constr.	April 1955	.....	Girdler	Girdler
B. F. Goodrich Chemical Co.	Calvert City, Ky.	Chemical Plt.	.....	$8,600,000	Under Constr.	.....	.....	Fluor	Fluor
B. F. Goodrich	Shelton, Conn.	Carbon Dioxide Plt.	25 tons	.....	Engineering	July, 1955	.....	Girdler	Girdler
Gulf Chemical Co. (United Gas & Others)	Pensacola, Fla. Vicinity	Anhydrous Ammonia Polyvinyl Chloride	.....	.....	Planned	.....	.....	.....	.....

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Gulf Oil Corp.	Philadelphia	Sulfur Recovery		$1,100,000	Under Constr.	2nd Qtr., 1955		Parsons	Parsons
Hercules Powder Co.	Burlington, N.J.	Dimethyl Terephthalate Plt.		$4,500,000	Under Constr.	May, 1955			
Ketona Chemical Corp. (Owned by Alabama By-Products & Hercules Powder)	Birmingham, Ala.	Anhydrous Ammonia Plt.	45,000 tons/yr.		Engineering	Late 1955		Fluor	Fluor
*Miami Oil & Refining Co.	West Palm Beach, Fla.	Refinery	15,000 bbls.	$12,000,000	Planning (Unconfirmed)				
Monsanto Chemical Co.	Springfield, Mass.	Styrene Compounding		$3,400,000	Under Constr.			Monsanto	Adams & Ruxton
Monsanto Chemical Co.	Springfield, Mass.	Research Fac.		$1,117,000	Under Constr.			Monsanto	D. O'Connel
Northern Chemical Industries	Searsport, Maine	Ammonia	125 tons	$9,000,000	Engineering	2nd Qtr., 1956	Texaco	Girdler	Girdler
		Nitric Acid	60 tons		Engineering		Du Pont	Girdler	Girdler
		Nitrogen Solutions	165 tons/yr.		Engineering			Girdler	Girdler
*Pontiac Eastern Corp.	Lumberton, Miss.	Refinery	12,000 bbls.	$10,000,000	Planning (Unconfirmed)				
*Simpson Coal Chemical	Natchez, Miss.	Acetylen	30,000 tons/yr.	$20,000,000	Planning (Unconfirmed)				
		Anhydrous Ammonia	165 tons/yr.						
Sinclair Refining Co.	MarcusHook, Pa.	Para-Xylene Plt.	10 mln. lbs./yr.	$2,200,000	Under Constr.			Badger	Badger
*Sinclair Refining Co.	MarcusHook, Pa.	Crude Stills	120,000 Gls.	$12,700,000	Planning	May, 1956		Sinclair	Parsons
Socony-Vacuum Oil Co.	Paulsboro, N.J.	Seva former Unit	20,000 bbls.		Under Constr.	July, 1955	Soc.-Vac.	Fluor	Fluor
*Spencer Chemical	Henderson, Ky.	Petrochemical Plt.		$1,750,000	Under Constr.	Summer, 1955		Staff	Quaker
Sun Oil Company	Marcus Hook, Pa.	Houdriflow Cat. Crker.	27,000 bbls.	$7,500,000	Under Constr.	April, 1955	Houdry	Houdry, Cat. Constr., Sun	Cat. Constr.
Sun Oil Company	Marcus Hook, Pa.	Houdriformer Cat. Unit	18,000 bbls.	$4,500,000	Under Constr.	May, 1955	Houdry	Sun, Houdry	Cat. Constr.Sun
Sun Oil Company	Marcus Hook, Pa.	Vacuum Unit	22,000 bbls.	$1,500,000	Under Constr.	May 1955		Sun, Cat. Constr.	Cat. Constr.
Sun Oil Co.	Marcus Hook, Pa.	Anhydrous Ammonia Plt.	300 tons	$9,000,000	Under Constr.	Nov., 1955		Cat. Constr.	Cat. Constr.
*Tennessee Gas Transmission	Inola, Miss.	Compressor Sta.	5500 HP.		Under Constr.	July, 1955		Staff	Olsen
Texas Company	Westville, N.J.	Cat. Reforming	12,000 bbls.		Complete			U.O.P., Procon Staff	Procon, Others
Texas Company	Westville, N.J.	Alkylation Fac.	1,850 bbls.		Complete			Staff	Cat. Constr., Others
Tide Water Associated Oil	Wilmington, Del.	Refinery	130,000 bbls.	$100,000,000	Planning	End, 1956		Braun	
Union Carbide & Carbon Corp.	Leaksville, N.C.	Dynel Fiber Plt.		$30,000,000	Planning	1955		Staff	
*Union Carbide & Carbon	Niagara Falls, N.Y.	Research Lab.		$1,957,229	ODM Cert.				
*Westvaco Chlor-Alkali Div.	South Charleston W. Va.	Anhydrous Ammonia Plt.	60 tons			Late 1955			Lummus
MID-CONTINENT									
Amerada Pet. Corp.	Williston Basin, N.D.	Natural Gasoline Plt.		$10,000,000	Planning				
Atlas Powder Co.	Site Undetermined	Anhydrous Ammonia Plt.		$6,750,000	ODM Certified				
Atlas Powder Co.	Site Undetermined	Glycerin Plt.		$5,940,000	ODM Certified				
Aurora Gasoline	Detroit, Mich.	Basic Refining		$400,000	Announced				
*Black Thunder Oil, Inc.	Newcastle, N.D.	Natural Gasoline Plt.	5Mmcf	$400,000	Complete			Russell	Russell
*Calumet Nitrogene Products Co.	Hammond, Ind.	Ammonia Nitrogen Fertilizer Plt.	300 Tons			May, 1956		Fluor	Fluor
Central Petroleum Co.	Cayle, Okla.	Gasoline Plt.			Authorized				
Champlin Refining Co.	Enid, Okla.	Expansion:							
		Fluid Cat. Crker.	9,000 bbls.	$4,000,000	Planned	Nov., 1955	Kellogg		Kellogg
		Platformer	5,000 bbls.		Planned	May, 1955	U.O.P.		Sweco
Commercial Solvents Corp.	Peoria, Ill.	Enlarge Nitroparaffin Derivatives Fac.			Planned				
Derby Oil	Wichita, Kans.	Platforming Unit		$2,700,000	Under Constr.				
Du Pont	Montague, Mich.	Neoprene Plt.			Planned	4th Qtr., 1956			
Great Northern Oil Company	Pine Bend, St. Paul, Minn.	Crude Topping	25,000 bbls.					Fluor	Fluor
		TCC Unit	12,000 bbls.				Soc-Vac.	Fluor	Fluor
		Ultraformer	5,000 bbls.				Indiana-Standard	Fluor	Fluor
		Hydrodesulfurizer	11,000 bbls.	$25,000,000	Under Constr.	3rd Qtr., 1955	Indiana-Standard	Fluor	Fluor
		Cat. Poly.	900 bbls.				U.O.P.	Fluor	Fluor
		Delayed Coker	480 tons					Fluor	Fluor
Great Plains Refinery Development Co.	Rapid City, S.D.	Refinery	3,000 bbls.	$3,100,000	Under Constr.	End, 1955		Succop	Succop
Gulf Oil Corp.	Toledo, Ohio	Refinery Fac.; Platformer	10,000 bbls.		Under Constr.	Early, 1955	U.O.P.	Procon	Procon
Gulf Oil Corp.	Cincinnati, Ohio	Platforming Unit & Aux. Units	70,000 bbls.		Under Constr.	April, 1955	U.O.P.	Procon	Procon
Hercules Powder Co.	Birmingham, Ala.	Anhydrous Ammonia Plt.	45,000 tons/yr.		Planning	1955			
International Refineries	Wrenchall, Minn.	Petroleum Refining Fac.		$9,500,000	ODM Approved				
*Mid-Continent Petroleum Co.	West Tulsa, Okla.	Expand Cat. Cracking	13500	$300,000	Engineering	Aug., 1955		Staff	Staff
Mid-Continent Petroleum Corp.	West Tulsa, Okla.	Delayed Coking	7,000 bbls.	$2,300,000	Under Contr.	Dec., 1955		Kellogg	Kellogg
Mid-West Refineries, Inc.	Alma, Mich.	Hydrogenation Unit & Related Fac.	2,500 bbls.	$368,000	Under Constr.				
Mississippi Chemical	Yazoo City, Miss.	Ammonia Plt.	120 tons	$2,000,000	Under Constr.		L'Air Liquide	Girdler, MCC Staff	Girdler, MCC Staff
Mississippi River Fuel Corp.	Crystal City, Mo.	Petrochem. Plt. Ammonia & Nitrates	200 tons	$15,000,000	Under Constr.	Oct., 1955	Texaco Dev.	Fluor	Fluor
Naph-Sol Refining Co.	Muskegon, Mich.	Cat. Reformer	6,000 bbls.		Planned				
*National Distillers Products	Tuscola, Ill.	Natural Gas Reforming Plt.			Under Constr.	Mid, 1955		Girdler	Girdler
National Petro-Chemicals	Tuscola, Ill.	Polyethylene Facilities	25 million lbs./yr.		Under Constr.	Spring, 1955	I.C.I.	Kellogg	Kellogg



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You'll find that our booklet—"The Collection and Recovery of Industrial Dusts"—explains *all three* Buell Dust Collection Systems simply and clearly. Write Dept. 21-D, Buell Engineering Company, 70 Pine Street, New York 5, New York.

*Built by C. F. Braun & Co.

MECHANICAL ELECTRICAL

buell

20 Years of Engineered Efficiency in **DUST COLLECTION SYSTEMS**

Petro-Chem Development Company Reports:

No Shutdowns *for* Refractories Maintenance

IN OVER

1200 FURNACES

In 1940, the Petro-Chem Development Company lined their first Iso-Flow furnace with B&W Insulating Firebrick. Today, over 1200 installations later, (some with fluid outlet temperatures over 1600F) not a single furnace has ever been shut down because of the need for refractory maintenance.

Long life is just one reason furnace builders, as well as furnace operators, insist on B&W IFB. Here are four more:

CUT INSTALLATION COSTS

B&W Insulating Firebrick are easy to install. They can be cut, drilled or shaped on the job with ordinary woodworking tools. Their lightness makes them easy to handle.

ELIMINATE EXPENSIVE ALLOYS

Because of their high insulating values, B&W Insulating Firebrick can be supported or anchored with ordinary carbon steel. Expensive, heat-resisting alloys are not necessary.

REDUCE DOWN-TIME

These brick have low heat storage, cool off quickly. This makes possible quick access to the furnace for inspection. They heat up quickly to get back on the line, too.

CLOSE TEMPERATURE CONTROL

Due to the low heat-storage capacity of B&W IFB, their hot-face temperature responds quickly to changes in the rate of heat input to the furnace — insuring the closest possible temperature control.

You, too, can profit by this four-way economy of B&W Insulating Firebrick. Ask your B&W representative for all the facts on these cost-cutting refractories. He'll be glad to discuss your refractory problems with you.

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

B&W REFRACTORIES PRODUCTS — B&W Allmul Firebrick • B&W 80 Firebrick • B&W Junior Firebrick • B&W Insulating Firebrick B&W Refractory Castables, Plastics and Mortars • OTHER B&W PRODUCTS—Stationary & Marine Boilers and Component Equipment... Chemical Recovery Units . . . Seamless & Welded Tubes . . . Pulverizers . . . Fuel Burning Equipment . . . Pressure Vessels . . . Alloy Castings

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Northwestern Refining Co.	St. Paul Park, Minn.	Gas Concentration Unit	.....	.....	Under Constr.	April, 1955	.....	.....	.....
Pana Refining Co.	Pana, Ill.	Modernization	†1,800 bbls.	$900,000	.....	.....	.....	.....	.....
Pana Refining	Pana, Ill.	Girbotol Unit	.....	.....	Under Constr.	.....	.....	.....	Parker
Pontiac Eastern Corp.	South Central, Miss.	Refinery	12,000 bbls.	$10,000,000	Planned	.....	.....	.....	Fluor
Prime Oil Co.	Calumet City, Ill.	Refinery	15,000 bbls.	$10,000,000	Planned	.....	.....	.....	.....
Sinclair Refining	E. Chicago, Ind.	Barrel House Fac.	.....	$2,700,000	Under Constr.	Summer, 1955	.....	Sumner Sollitt	Sumner Sollitt
Sinclair Refining Co.	E. Chicago, Ind.	Cat. Reformer	16,000 bbls.	$13,000,000	Under Constr.	Spring, 1955	.....	.....	Braun
*Sinclair Refining Co.	East Chicago, Ill.	Cat. Cracking Expan.	.....	$3,252,000	ODM Cert.	.....	.....	.....	.....
Standard-Indiana	Whiting, Ind.	Fluid Hydroformer	27,000 bbls.	.....	Under Constr.	Early, 1955	.....	.....	Kellogg
Standard-Indiana	Whiting, Ind.	Heavy Oils Modern.	.....	.....	Engineering	Early, 1956	.....	.....	Foster Wheeler
Standard-Indiana	Whiting, Ind.	Crude Unit	55,000 bbls.	.....	Planning	Early, 1956	.....	.....	Braun
Standard-Indiana	Wood River, Ill.	Coking Unit	8,500 bbls.	.....	Planning	1958	.....	.....	.....
*Standard-Indiana	Wood River, Ill.	Ultraformer	8,000 bbls.	.....	Under Constr.	Early, 1955	.....	.....	Kellogg
Standard-Indiana	Mandan, N. D.	Ultraformer	5,400 bbls.	.....	Planning	Late 1956	.....	.....	.....
Standard-Indiana	Sugar Creek, Mo.	Ultraformer	12,600 bbls.	.....	Engineering	Late, 1955	.....	.....	Parsons
*Standard-Indiana	Seymour, Ind.	Solid Rocket Propellant Pilot Plt.	.....	.....	Planning	July, 1955	.....	.....	.....
Standard-Indiana & Sinclair	Hammond, Ind.	Anhydrous Ammonia	300 tons	.....	Planned	Early, 1956	.....	.....	.....
Standard Oil of N.D.	Grand Forks, N.D.	Refinery	2,000-2,500 bbls.	.....	Planning	.....	.....	.....	.....
*Standard Oil Co. (Ohio)	Lima, Ohio	Cat. Polymerization Unit	.....	$335,000	ODM Cert.	4th Qtr., 1956	.....	.....	.....
Standard Oil Company (Ohio)	Lima, Ohio	Petrochemical Plt: Anhydrous Ammonia	300 tons	$17,000,000	Under Constr.	Nov., 1955	.....	.....	Kellogg
		Nitric Acid	60 tons						
		Nitrogen Solution	200 tons						
		Offsite Fac.	.....	.....	.....	.....	.....	.....	McKee
Standard, Ohio		Urea Plt.	120 tons	.....	Under Constr.	Late 1955	Vulcan	Vulcan Engr. Div.	McKee
*Standard (Ohio)	Cleveland, Ohio	Refinery	15,000 bbls.	$4,400,000	ODM Cert.	4th Qtr., 1956	.....	.....	.....
*St. Paul Ammonia Products Co.	Pine Bend, Minn.	Anhydrous Ammonia Plt.	200 tons	$15,000,000	Planning (Unconfirmed)	April, 1956	.....	.....	.....
Sun Oil Co.	Toledo, Ohio	Houdriflow Cat. Crker.	27,000 bbls.	$6,000,000	Under Constr.	April, 1955	Houdry	Houdry, Cat. Constr., Sun	Cat. Constr.
The Texas Co.	Lawrenceville, Ill.	Cat. Reformer	13,631 bbls.	.....	Under Constr.	2nd Qtr., 1955	.....	U.O.P.	Lummus, Others
	Lawrenceville, Ill.	Alkylation Unit	2,253 bbls.	.....	Under Constr.	2nd Qtr., 1955	.....	Lummus, Others	
The Texas Co.	Tulsa, Okla.	Platform. Unit	9,040 bbls.	.....	Under Constr.	3rd Qtr., 1955	.....	U.O.P., Refinery	Refinery & Others
The Texas Co.	Lockport, Ill.	Platformer	10,854 bbls.	.....	Under Constr.	3rd Qtr., 1955	.....	U.O.P. and McKee	McKee
The Texas Co.	Lockport, Ill.	Alkylation Plt.	1,000 bbls.	.....	Under Constr.	3rd Qtr., 1955	.....	Staff	.....
Vulcan Asphalt Refining Co.	Cordova, Ala.	Relocation of Refinery	2,200 bbls.	$122,700	ODM Approved	.....	.....	.....	.....
Warren Petroleum Corp.	Lindsay, Okla.	Absorption & Compr. Fac.	.....	$1,400,000	Complete	.....	.....	Gas Plt. Constr.	Gas Plt. Constr.
Warren Petroleum Corp.	Antioch, Okla.	Distl. Plt.	.....	$2,800,000	Under Constr.	June, 1955	.....	Gas Plt. Constr.	Gas Plt. Constr.
Warren Petroleum Corp.	Maysville, Okla.	Extraction Enlargement	19,000 bbls.	$2,800,000	Under Constr.	June, 1955	.....	Gas Plt. Constr.	Gas Plt. Constr.
*Wisconsin Oil Refining Co.	Sheboygan, Wis.	Vacuum Unit	2,500 bbls.	.....	Planning	.....	.....	Koch	.....
SOUTHWEST									
Allied Chem. & Dye Corp.	Orange, Texas	Ethanolamines	.....	.....	.....	1955	.....	.....	.....
American Republics Corp., et al	Silsbee, Texas	Gaso. Plt.	20 Mmcf	$1,000,000	Under Constr.	Aug., 1955	.....	Braun	Olsen
Carbide and Carbon Chemicals Co.	Seadrift, Texas	Butadiene Plt.	.....	$2,295,000	Complete	.....	.....	.....	.....
Chillicothe Petrochemicals, Inc.	Chillicothe, Tex.	Petrochemical Plt.							
		Ammonia	180-200 tons	$12-14,000,000	Unconfirmed	.....	.....	.....	.....
		Urea	150 tons						
Cities Service Oil Co., et al	Seminole, Texas	Nat. Gas Plt.	55,000 gals.	.....	Planning	.....	.....	.....	Delta
Columbian Carbon Co.	North Bend, La.	Carbon Black Plt.	60,000,000 lbs./yr.	.....	Under Constr.	Initial Unit Complete Nov., 1954; Entire Plt. Nov., 1955	.....	.....	.....
Commercial Solvents Corp.	Sterlington, La.	Nitroparaffins Fac.	10,000,000 lbs./yr.	$5,000,000 (Incl. Peoria, Ill.)	Under Constr.	3rd Qtr., 1955	.....	Staff & Texas	Ford, Bacon & Davis
Cons. Chem., Ind.	Baytown, Tex.	Alky. Sulfuric Acid-Regen. Plt. & Sulfur Burning Acid Plant	600 tons	$4,500,000	Under Constr.	July, 1955	.....	Chemico	Chemico
Cons. Chem., Ind.	Houston, Texas	Alky. Sulfur Acid-Regen. Plt.	400 tons	$3,500,000	Under Constr.	July, 1955	.....	Chemico	Chemico
Corpus Christi Refining Co.	Tucker, Texas	Modernization	.....	.....	Planned	.....	.....	.....	.....
Danaho Refining Co.	Pettus, Texas	TCC Cat Crker. w/Reform.	3,500 bbls.	$2,600,000	Under Constr.	3rd Qtr., 1955	Sec.-Vac.	Koch	.....
		Cat. Poly.	265 bbls.	.....	.....	.....	.....	.....	.....
		Crude Expan.	7,500 bbls.	.....	.....	.....	.....	.....	.....
		Gas Conc.	.....	.....	.....	.....	.....	.....	.....
Danaho Refining Co.	Pettus, Texas	Platformer	1,000 bbls.	.....	Complete	.....	U.O.P.	Staff	Staff
Dow Chemical Co.	Velasco, Texas	Glycerin Unit, Polyethylene	.....	$18-20,000,000	Under Constr.	Jan., 1956	.....	.....	.....
					Under Constr.	Aug., 1955	.....	.....	.....
Dow Chemical Co.	Freeport, Texas	Soda Ash Plt.	200 tons	$3,000,000	Under Constr.	1955	.....	.....	.....
Eastern States Petroleum Co.	Houston, Texas	Coking Plt.	12,000 bbls.	$4,000,000	Projected	.....	.....	.....	.....
Esso Standard	Baton Rouge, La.	Fluid Hydroforming Unit	25,000 bbls.	$1,280,000	Complete	.....	.....	S.O.D., Braun	Braun
Ethyl Corp.	Baton Rouge,	15% Increase in Anti-Knock Compound Output	.....	.....	Under Constr.	Early, 1955	.....	.....	.....
Ethyl Corp.	Houston, Texas	15% Increase in Anti-Knock Compound Output	.....	.....	Under Constr.	Early, 1955	.....	.....	.....

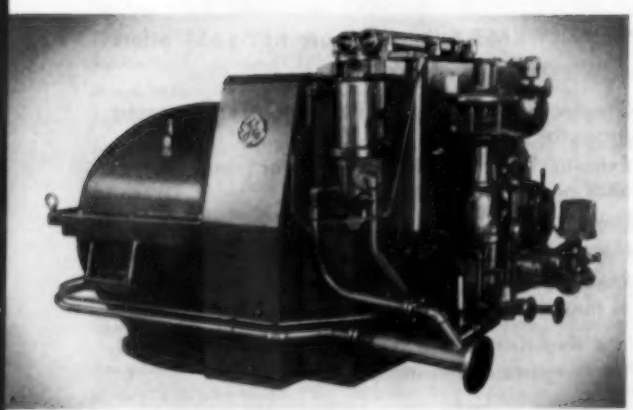
REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
D. D. Feldman Co.	Lake Arthur, La.	Petrochem. Plt.		$643,000	Applied for certificate of necessity				
*Great Southern Chemical Corp.	Corpus Christi, Texas	Hydrogen Compressor Platforming		$94,000	ODM Cert.				
Gulf Oil	Port Arthur, Texas		20,000 bbls.		Under Constr.	2nd Qtr., 1955	U.O.P.	Fluor	Fluor
*Gulf Oil	Port Arthur	Crude Topping	100,000 bbls.		Engineering	Spring, 1955		McKee	McKee
		Catalytic Cracking Unit	58,500 bbls.		Engineering	Spring, 1955		Kellogg	Kellogg
Gulf Oil	Port Arthur, Texas	Exp. Ethylene Fac.	3,000 Mmcf/yr.		Under Constr.	2nd Qtr., 1955		S&W, Badger Div.	S&W, Badger Div.
Gulf Oil	Port Arthur, Texas	Gas Purification Unit			Under Constr.			Girdler	Girdler
Gulf Refining, Humble Oil & Refining, The Texas Co.	St. Landry Parish, La.	Cycling & Gasoline Plt.	100 Mmcf	$10,000,000	Completing	June, 1955			
Gulf Refining	St. Landry Parish, La.	Nat. Gaso. Fac.		$5,000,000		2nd Qtr., 1955			
*Honolulu Oil Corp.	Nolan County, Texas	Gas Gathering sys. 65 Mmcf	1,210 bbls.	$11,150,000	Completed				
		Nat. Gaso. Plt.						Fluor	Fluor
*Humble Oil & Refining Co.	Baytown, Texas	Clay Treating Unit	12,000	$480,000	Under Constr.	May, 1955		Braun	Braun
*Humble Oil & Refining Co.	Baytown, Texas	Hydrofining Unit	8,100	$1,525,000	Under Constr.	May, 1955		Lummus	Lummus
*Humble Oil & Refining Co.	Baytown, Texas	Desulfurization Unit	30,875	$800,000	Under Constr.	May, 1955		Fluor	Fluor
*Humble Oil & Refining Co.	Baytown, Texas	Hydroformer No. 1	16,000	$4,000,000	Under Constr.	July, 1955		Kellogg	Kellogg
*Humble Oil & Refining Co.	Baytown, Texas	Hydroformer No. 2	16,000	$4,100,000	Under Constr.	June, 1955		Humble	Humble
*Humble Oil & Refining Co.	Baytown, Texas	Deresining Unit		$1,630,000	Under Constr.	Aug., 1955		Koppers	Koppers
Koppers Co.	Port Arthur, Tex.	Polyethylene Plt.		$4,500,000	Under Constr.	Mid 1955			Delta
Magnolia Petroleum Co.	Vanderbilt, Tex.	Gaso. Plt. Exp.	30 Mmcf		Complete				
McBride Refining Co.	Port Brownsville, Texas	Ref. Expan.	†12,500 bbls.	$2,500,000	Planned				
McMurrey Refining Co.	Tyler, Texas	Avia. Gaso. Plt.		$3,000,000	Engineering	June, 1955		Blaw-Knox, Kellogg	Blaw-Knox
McMurrey Refg. Co.	Port Brownsville, Texas	Ref. Expan.	†12,500 bbls.	Planned					Kellogg
Monsanto Chemical	Texas City, Tex.	Polyethylene Plt.	66,000,000 lbs./year		Complete			Monsanto	Farnsworth & Chambers
*The Murmanill Corp.	Fairbanks, Tex.	Compressor and Dehydration Plt.	3,840 HP.	$850,000	Complete			Olsen	Olsen
*Northeast Texas Chemical Co.	East Texas	Chemical and Fertilizer Plt.			Planning			Texas	Beck
*Oil & Gas Property Management	Old Ocean, Tex.	Pressure Maintenance Plt.	750 HP.	$225,000	Complete			Olsen	Olsen
Pan American Ref.	Texas City, Tex.	Ultraforming	21,200 bbls.		Complete				Kellogg
Payne & Johnston, & B. G. Hyatt	Nolan County, Texas	Nat. Gaso. Plt.	6-8 Mmcf		Complete				Gaso. Plt.
Petrolite Corp.	Sweeny, Texas	Pet. Ref.		$25,899	DPA Certified				
Petrolite	Destrehan, La.	Pet. Ref.		$60,000	DPA Certified				
*Phillips Petroleum Co.	Borger, Texas	Distillate Hydrogenation Unit	10,000 bbls.	$488,000	ODM Cert.				
*Phillips Petroleum Co.	Borger, Texas	Catalytic Reforming Unit	16,000 bbls.	$5,395,000	ODM Cert.				
*Phillips Petroleum Co.	Phillips, Texas	Catalytic Reformer	16,000 bbls.		Under Constr.	Fall, 1955			
*Phillips Petroleum Co.	Phillips, Texas	Dehydration Unit			ODM Cert.				
Premier Pet. Co.	Longview, Tex.	Cat. Poly. Plt.			Under Constr.				
*The Pure Oil Co.	Smith Bluffs, Texas	Cat. Reformer			Planned				
Shell Chemical Corp.	Houston Texas	Glycerine Plt. Extension			Complete			Pioneer	Pioneer
Shell Chem. Corp.	Houston, Texas	Epon Plt. Exp.			Under Constr.	2nd Qtr., 1955		Lummus	Lummus
Shell Chemical Corp.	Norco, La.	Chlorohydrin Plt.			Complete			Fluor	Fluor
*Shell Oil Co.	Norco, La.	Refinery Expan.	†75,000 bbls.	$30,000,000	Planning				
Shell Oil	Iowa, La.	Inc. Cap. Gaso. Plt	†55 Mmcf	$600,000	(Unconfirmed) Complete			Olsen	Olsen
*Sinclair Refining Co.	Houston, Texas	Cat. Reforming Unit	24,000 bbls.	$16,500,000	Planning	1956			
Sinclair Refining	Houston, Texas	Cat. Reformer	24,000 bbls.	$16,500,000	Planning			Sinclair	
Spencer Chemical	Orange, Texas	Polyethylene Plt.	45,000,000 lbs./year	$15,000,000	Complete		I.C.I. of England	Staff, Hedrick Engineering	Quaker Valley Constr.
Standard Oil Co. of Texas	El Paso, Texas	Platformer	4500 bbls.	$2,700,000	Under Constr.	Aug., 1955	U.O.P.	Bechtel	Bechtel
*Stanolind Oil & Gas Co.	Ector County, Texas	Gas Comp.		$200,000	ODM Cert.				
Stanolind Oil & Gas	Brownsville, Texas	Reconditios & Revamp			Under Constr.	Fall, 1956		Lummus	Lummus
Sunray Oil Corp.	Branch, La.	Cycling & Gaso. Plt.	24 Mmcf	$1,500,000	Under Constr.	Dec., 1955			
Suntide Refining Co.	Corpus Christi, Texas	Alkyl. Expan.	To 70,000 bbls.		Projected				
*Tennessee Production Co.	Banquete, Tex.	Gasoline Plt. Ext.		$200,000	Complete			Olsen	Olsen
*Tennessee Production Co.	Chesterville, Texas	Gasoline Plt. Ext.		$250,000	Complete			Olsen	Olsen
The Texas Co.	Port Arthur, Texas	No. 2 Catalytic Reformer Expan. & Med. Atmos. Crude Pipe Still, Delayed Coker, Cat. Poly., Treating & LPG Handling Facilities	20,000 bbls.		Under Constr.	2nd Qtr., 1955		Staff, U.O.P. and Others	Lummus and Others
Texas Butadiene & Chemical Corp.	Settegast, Texas	Aviation Alkylate, Butylenes & Butadiene	5,000 bbls.	$20,500,000	Planned				Fluor
Texas Natural Gasoline Corp.	Coke County, Texas	Gathering System & Nat. Gaso. Plt.	70 Mmcf		Under Constr.	Oct., 1955		Fluor	Fluor

TURBINES FOR
HIGH-SPEED COMPRESSORS

OIL DAM IN UPPER BEARING HALF, located at pencil point, restricts oil flow around shaft, building up a pressure pad as shown at left. As turbine gains speed, oil pressure increases and forces shaft down into ample surfaces of lower bearing liner, above right, assuring stability at high speed.

Large pressure-pad bearings add years of life to G-E high-speed turbines



TYPE DRV HIGH-SPEED MECHANICAL-DRIVE TURBINE

To provide longer, more reliable service, all G-E high-speed turbines incorporate large pressure-pad bearings. The generous surfaces of the bearings assure low unit loading for ample lubrication and minimum wear during start-up.

As turbine speed increases, the viscous pump action of the shaft carries oil into the cavity, building up a pressure pad. This forces the shaft down into the lower bearing half, thus minimizing the possibility of vibration, with its detrimental effect on bearing and packing life.

This is only one of many design features that make a G-E high-speed turbine your most reliable drive for compressors and blowers. For more information contact your nearest G-E Apparatus Sales Office. General Electric Company, Schenectady 5, N. Y. In Canada, contact Canadian General Electric Company, Limited, Toronto. 241-1

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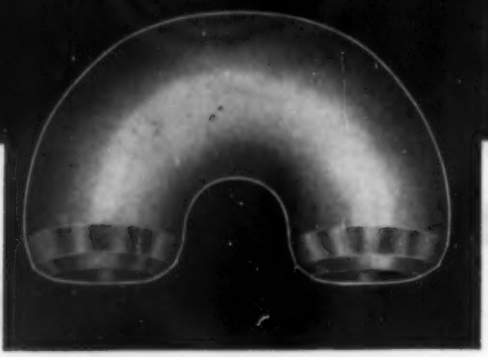

EASTERN STATES PETROLEUM CO.

Finished in the record-breaking time of eight weeks, the new Unifiner of Eastern States Petroleum Co., Inc., Houston, Tex., is producing at a capacity even greater than anticipated—a tribute to the skill of the men who designed and built it, and to the quality of the materials used in its construction.

KEY-KAST 180° weldable U-bends were selected to serve the piping system of this efficient new Unifiner. More and more refineries, in fact, are specifying KEY-KAST fittings because KEY-KAST offers these outstanding advantages:

- Greater wall thickness throughout — for increased structural strength
- Extra thickness in critical areas — for greater allowance against erosion
- Lower unit cost
- Meet A.S.M.E. and A.S.A. Codes
- Rigid testing and inspection to meet high standards of quality

There's a Key-Kast fitting for every alloy piping need. Write for complete information.

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Since 1916 . . . manufacturers and developers of products for high temperatures and pressures

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REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
ROCKY MOUNTAIN									
Arizona Refineries	Coolidge, Ariz.	Refinery	25,000 bbls	Part of $100,000,000 Project	Planning	Jan., 1956		Ebasco Services	
Atlantic Refining Co.	Lovington, N.M.	Natural Gas	25 Mmcf.		Projected				
Jack Bishop Group	Phoenix, Ariz.	Refinery	5,000 bbls.	$6,000,000	Proposed (Unconfirmed)				
Continental Oil, et al	Brush, Colo.	Nat. Gaso. Plt. & Gathering System	10 Mmcf		Complete				Fish
Continental Sulphur & Phosphate Corp.	Thermopolis, Wyoming	Sulfur Extraction	50 tons/yr.		Under Constr.		American Sulfur & Refining		Chemico
Cullen Group	Newcastle, Wyo	Gas Plt.		$4,500,000	Planned				
Famarim Oil & Refining Co.	Monument, N. M.	Cat. Reforming Unit	650 bbls.	$375,000	Scheduled	Spring, 1955	U.O.P.	U.O.P.	Famarim Oil & Refining Co.
First National Petroleum Corp.	Jensen, Utah	Ref. Expan.	To 3,000 bbls.		Planned				
*Frontier Refining Co.	Cheyenne, Wyo.	Refinery	17,500 bbls.	$1,500,000	Under Constr.	Summer, 1955	U.O.P.	U.O.P.	Procon
Navajo Refineries	Albuquerque, N. M.	Refinery	10,000 bbls.	Part of $100,000,000 Project	Planning	Jan., 1956		Ebasco Services	
Pure Oil Co., et al	Adena Field, Colo.	Nat. Gaso. Plt.	20 Mmcf	$3,000,000	Under Constr.	June, 1955			Stearns-Roger
*Salt Lake Refining Co.	Davis County, Utah	Catalytic Cracking Unit	4,100 b/d	$3,330,000	ODM Certified	6-1-55	S.O.D.	Fluor	Fluor
Salt Lake Chemical Co.	Salt Lake City, Utah	Synthetic Ammonia Plt.	120 tons of Ammonia 30 tons dry ice.	$7,800,000	Planned			Texas	Texas, Henry C. Beck Co.
Salt Lake Refining Co.	Salt Lake City, Utah	Fluid Cat. Crker	8,000 bbls.	$2,500,000	Complete			Fluor	Fluor
*Shell Oil Co. and Others	Sterling, Colo.	Gas Comp. Plt.	4.5 Mmcf		Completed			Blaw-Knox	Blaw-Knox
*Sioux Oil Co.	Newcastle, Wyo.	Expan. of Two Refineries	5,000 bpd	Part of $4,000,000 project	Planning	1955		Pervin & Gurtz	
Standard-Indiana	Casper, Wyo.	Heavy Oils, Mod. & Expan.			Planning	1957			
*Union Oil Co. (Calif.)	Rifle, Colo.	Shale Oil Pilot Plt.		$5,000,000	Planning				
U. S. Steel Corp	Geneva, Utah	Anhydrous Ammonia	200 tons	$20,000,000	Planned	1956		Blaw-Knox	Blaw-Knox
Utah Chemical Co.	Sanpete Valley, Utah	Ammonia Plt.	278 tons	$18,800,000	Planned	End, 1955			Cat. Constr.
*Utah Oil Refining	Salt Lake City, Utah	Ultraformer	5,500 bbls.		Planning	1956			
*Valley Gas Corp.	Lea County, N. M.	Nat. Gaso. Plt.	5 Mmcf		Under Constr.	June, 1955		F. S. West	F. S. West
Warren Petroleum Corp.	Monument, N.M.	Extraction Enlargement	5,100 bbls.	$630,000	Complete			Staff	Trend Constr. Co.
Warren Petroleum Corp.	Lovington, N. M.	Add. Distl. & Compr. Fac.	2,300 bbls.	$1,700,000	Complete			Staff	Dresser Engr. Co.
Western States Refg.	Salt Lake City	Topping; Crker.	2,000/2,200 bbls.	$1,100,000					
WEST COAST									
Brea Chemicals, Inc.	Brea, Calif.	Nitric Acid & Ammonium Nitrate Plt.	137 tons	$3,000,000	Under Constr.	Aug. 1955		C & I	C & I, Macco
*California Stray Chemical	Richmond, Calif.	Fertilizer Plt.		$3,000,000	Planning	Mid-1956			
Calstate Refg. Co.	Signal Hill, Calif.	Hyperformer Unit	1,100 bbls.	$300,000	Under Constr.		Union Oil		Calstate
Caminol	Hanford, Calif.	Petroleum Refining Fac.		$1,600,000	ODM Approved				
Carbide & Carbon Chemicals Company	Torrance, Calif.	Polyethylene Plt.	60 million lbs./yr.	$36,000,000	Under Constr.	End, 1955			
Columbia River Chemicals	Pasco, Wash.	Anhydrous Ammonia Urea Ammonium Sulfate	160 tons 110 tons 140 tons	$12,000,000	Under Constr.	Late 1955		Fluor	Fluor
*Du Pont	Antioch, Calif.	Fluorinated Hydrocarbons.							
*Fletcher Oil Co.	Wilmington, Calif.	Topping Unit	10,000 bbls.	$976,000	ODM Cert.				
Hancock Oil Co.	Signal Hill, Calif.	Cat. Crker. & Facilities	6,000 bbls.	$3,500,000	Under Constr.	Feb., 1955	Sun-Vac.	Parsons	Parsons
Hancock Oil Co.	Signal Hill, Calif.	Cat. Poly.	800 bbls.		Under Constr.	Feb., 1955	U.O.P.	Parsons	Parsons
Hancock Oil Co.	Signal, Hill Calif.	Fluid Coking Unit	6,000 bbls.	$1,814,800	ODM Certified				
Hancock Oil Co.	Long Beach,	Cat. Reformer	2,500 bbls.	$550,000	ODM Certified				
Pacific Oil & Refining Co.	Tacoma, Wash.	Refinery	10,000 bbls.		Under Constr.				
Rothschild Oil	Santa Fe Springs, Calif.	Cat. Crker.	6,000 bbls.	$2,000,000					Braun
Shell Chem. Corp.	Martinez, Calif.	Ionol Plt. Exp.			Under Constr.	3rd Qtr., 1955		Staff	Staff
Shell Oil	Anacorten, Wash.	Refinery	50,000 bbls.	$75,000,000	Under Constr.	End, 1955		Bechtel	Bechtel
Signal Oil & Gas	Los Angeles, Calif.	Butanes-Isobutane		$500,000					
*Standard (Calif.)	Richmond, Calif.	Ammonia Plt.	270 tons	$9,500,000	Planning	Mid-1955			
*Standard (Calif.)	Richmond, Calif.	Nitric Acid Plt.	225 tons	$2,500,000	Planning	Mid-1956			
Standard (Calif.)	Richmond, Calif.	Isophthalic Plt.	50 mln. lbs./yr.	$10,900,000	Engineering	Oct., 1955		Staff	Ferguson
Standard (Calif.)	Richmond, Calif.	Cat. Reformer	20,000 bbls.	$30,000,000	Completing	April, 1955		Bechtel	Bechtel
	El Segundo, Calif.	Cat. Reformer			Under Constr.			Bechtel	Bechtel
Standard Oil (Calif.)	El Segundo, Calif.	Offsite Fac.			Under Constr.			Fluor	
Standard Oil (Calif.)	Honolulu Territory of Hawaii	Refinery	20-30,000 bbls.	$25-30,000,000	Planned				
Stauffer Chemical	Compton, Calif.	Sulfuric Acid		$57,070	Engineering				
Stauffer Chemical	Richmond, Calif.	Sulfuric Acid		$283,500					
Sunset Oil Co.	Portland, Ore.	Refinery	20,000 bbls.		Considering				
The Texas Co.	Wilmington, Calif.	Platforming	10,000 bbls.		Under Constr.	2nd Qtr., 1955		U.O.P., Braun & Others	Braun & Others
The Texas Co.	Wilmington, Calif.	Hydrotreating	10,000 bbls.		Under Constr.	3rd Qtr., 1955		U.O.P., Braun & Others	Braun & Others
The Texas Co.	Wilmington, Calif.	Isomerization	1,000 bbls.		Under Constr.	2nd Qtr., 1955		Staff	Staff

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Union Oil (Calif.)	Oleum, Calif.	Unicol Unit	5,000 bbls.	.....	Complete	.....	.....	Fluor	Fluor
Union Oil (Calif.)	Oleum, Calif.	Sulfur Plt.	50 tons	.....	Complete	.....	.....	Fluor	Fluor
Union Oil (Calif.)	Los Angeles	Fac. for Handling Enriched Crude	.....	$950,000	Engineering	.....	.....	Fluor	Fluor
*Union Oil Co. (Calif.)	Los Angeles	Gas, Oil & Heavy Side Cut Strippers	.....	$250,000	Planning	.....	.....	Fluor	Fluor
Union Oil (Calif.)	Santa Maria, Calif.	Coking Plt.	18,700 bbls.	$16,475,000	Complete	.....	.....	Bechtel	Bechtel
Union Oil (Calif.)	Santa Maria, Calif.	Sulfur Plt.	42 tons		Complete	.....	.....	Girdler	Bechtel
OUTSIDE U.S.A.									
Canada									
British-American Oil Co.	Calgary	Cat. Reformer	2,000 bbls.	.....	Complete	.....	Atlantic	Fluor	Fluor
British-American Oil Co.	Montreal	Cat. Reformer	13,000 bbls.	$3,000,000	Planned	Late, 1955	Atlantic	Lummus	Lummus
British Dominion Oil Co.	Southern Alberta, Canada	Ammonium Nitrate	.....	$1,800,000	Planning (Unconfirmed)	.....	.....	.....	.....
Can-Amera Oil-Sands Development, Ltd.	Edmonton, Alta.	Processing Plt.	.....	.....	Unconfirmed	.....	.....	.....	.....
*Canadian Hydrocarbons, Ltd.	Winnipeg, Manitoba	Ammonia Plt.	.....	.....	Planning (Unconfirmed)	.....	.....	.....	.....
Canadian Industries, (1954) Ltd.	Milhaven, Ont.	"Terylene" Plt.	11,000,000 lbs./yr.	$20,000,000	Pilot Plt in Operation	Mid 1955	.....	Ferguson	Ferguson
*Canadian Oil Companies, Ltd.	Sarnia, Ontario	Carbon Monoxide Steam Generator	.....	$400,000	.....	Oct., 1955	.....	.....	Combustion Engineering
Canadian Petrofina, Ltd.	Montreal, Quebec, Canada	Refinery, Houdriflow Cat. Cracker, Cat. Poly Dist. Unit, Vacuum Dist., Ultraformer, Fluid Coker, Alkylation, Auxiliary, Fac., Hydrodesulfurization	20,000 bbls.	$20,000,000	Under Constr.	Late 1955	Houdry, Standard of Ind., Kellogg, Standard of N.J.	.....	Canadian Kellogg & Lummus
Canada Southern Oils	Saskatchewan	Refinery	10-20,000 bbls.	$7,000,000-$10,000,000	.....	.....	.....	.....	.....
Consolidated Mining & Smelting of Canada	Calgary, Alta.	Urea Plt.	.....	.....	Considering	.....	.....	.....	.....
*Dawson Chemical Company	Valleyfield, Quebec	Synthetic Fluid Cracking Cat-Catalyst Plt.	.....	$6,000,000	.....	.....	.....	Stone & Webster	.....
*Ethyl Corporation of Canada, Ltd.	Sarnia, Ont.	Anti-Knock Compound Plt.	.....	.....	Planning	Early, 1956	.....	.....	.....
Excelsior Refineries, Ltd.	Dawson Creek, B.C.	Thermal Cracking Unit	2,000 bbls.	$1,500,000	Under Constr.	July, 1955	.....	.....	Can. Kellogg
Hooker Chemicals, Ltd.	N. Vancouver, B. C.	Chemicals	.....	.....	Projected	.....	.....	.....	.....
*Husky Oil & Refining, Ltd.	Moose Jaw, Sask.	Catformer, Desulfurization Unit, Vacuum Dist., Vis-Breaker, Crude Furnace	15,000 bbls.	.....	Under Constr.	July, 1955	.....	Fluor	Fluor
*Husky Oil & Refining, Ltd.	Port William, Ont.	Expansion Catformer, Desulfurization Unit Asphalt Plt.	15,000 bbls.	$1,000,000	Under Constr.	July, 1955	Atlantic	Fluor	Fluor
*Husky Oil & Refining, Ltd.	Lloydminster, Alta.	Refinery Expan.	18,500 bbls.	$1,000,000	Completing	.....	.....	.....	.....
Imperial Oil	Sarnia, Ontario	Quality Control Lab. Packaging & Shipping Plt. and Mech. Shops	.....	$6,000,000	Under Constr.	1955	.....	.....	Canadian Bechtel
Imperial Oil, Ltd.	Edmonton, Alberta	Lube Oil Plt.	22,000 bbls.	$14,000,000	Under Constr.	July, 1955	.....	Staff & Can. Kellogg	Can. Kellogg
Imperial Oil, Ltd.	Impercoyal, Canada (near Halifax)	Rebuild Existing Plt. including Fluid Cat.	41,625 bbls.	$25,000,000	Under Constr.	Summer, 1956	.....	Staff & Can. Kellogg	Can. Kellogg
*Imperial Oil, Ltd.	Ioco, B.C.	Naphtha Fractionator & Cat. Poly. Plt.	2,000 bbls.	$2,900,000	Under Constr.	Oct., 1955	.....	Staff & Can. Bechtel	Can. Bechtel
*Inland Chemicals Canada, Ltd.	Fort Saskatchewan, Alta.	Sulfuric Acid Plt.	100 tons	$1,000,000	.....	.....	.....	.....	Lummus of Canada
*International Wares, Ltd.	Toronto	Contact Plt.	†140,000 lb.	$350,000	Planning	.....	.....	.....	.....
Kendall Refg. of Canada	Toronto, Canada	Cracker Lub. Oil Compounding, packaging & Distrib Plt.	27,000 bbls.	.....	Considering	Summer, 1956 Indefinite	.....	.....	.....
McColl Frontenac Oil Co.	Edmonton, Alberta	Capacity Increase	11,000 bbls.	$4,000,000	Under Constr.	July, 1955	.....	Staff	.....
McColl-Frontenac Oil Co.	Edmonton, Alberta	Thermal Cracking Unit	3,000 bbls.	.....	Engineering	July, 1955	.....	Can. Kellogg	Can. Kellogg
McColl-Frontenac	Montreal, East	Platformer	12,000 bbls.	.....	Engineering	May, 1955	U.O.P.	Procon Can.	Procon Can.
Midland Pet. & Pacific Pet.	Stettler, Alta.	Crude Refinery	4,000 bbls.	$2,000,000	Under Constr.	.....	.....	.....	.....
North Star Oil, Ltd.	St. Boniface, Manitoba	Refinery	12,000 bbls.	$10,000,000	Under Constr.	July, 1955	U.O.P.	Can. Kellogg	Can. Kellogg
*Northwest Nitro-Chemicals, Ltd.	Alberta	Nitrogen Plt.	.....	$20,000,000	Planning	End, 1956	.....	Commercial Solvents	Ford, Bacon & Davis
*Polymer Corp., Ltd.	Sarnia, Ont.	Ethylene Plt. Expan.	.....	$2,000,000	Under Constr.	1956	.....	Staff	Staff
*Polymer Corp., Ltd.	Sarnia, Ont.	Additional Turbo-generator—Steam and Power Plt.	.....	$500,000	Equipment	1956	.....	.....	Canadian General Electric
Royalite Oil Co.	Kamloops, B.C.	FluidCat Crker., Poly & Gas Concentration	1,425 bbls.	$2,500,000	Under Constr.	Mar., 1955	U.O.P.	Caribou Eng. Co.	Caribou Eng. Co.

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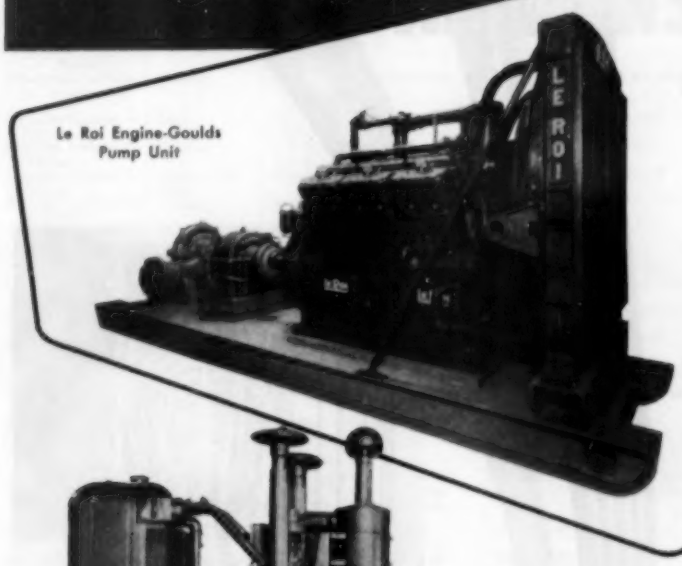
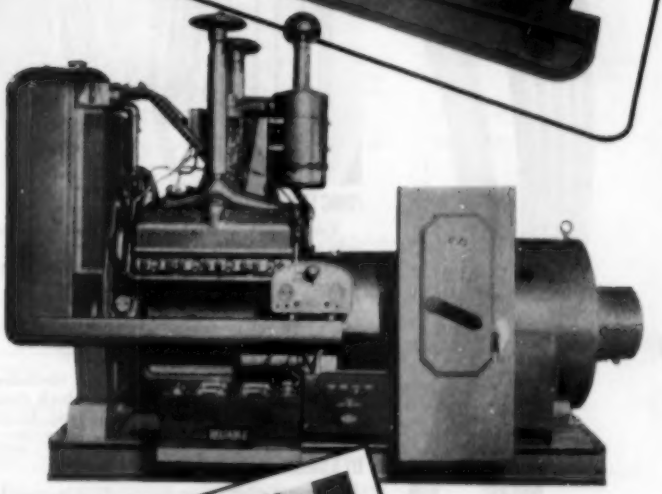
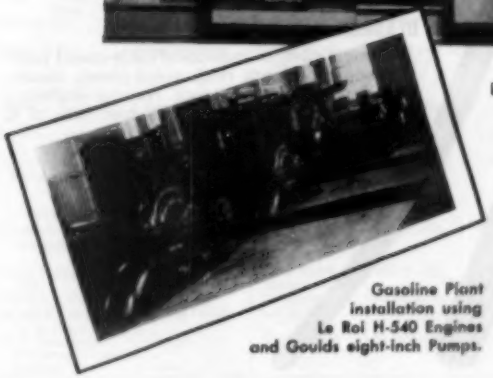


Le Roi Engine-Goulds Pump Unit



Le Roi Gas Engine Generator Unit



Gasoline Plant installation using Le Roi H-540 Engines and Goulds eight-inch Pumps.

For almost half a century Southern Engine & Pump Company has been serving the Petro-Chemical Industry. And for pumping or driving generator units in refinery and gasoline plants, our engineers have found there's no more dependable source of power than famous Le Roi engines.

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For more data on advertised products, use Readers' Service Cards, last page.

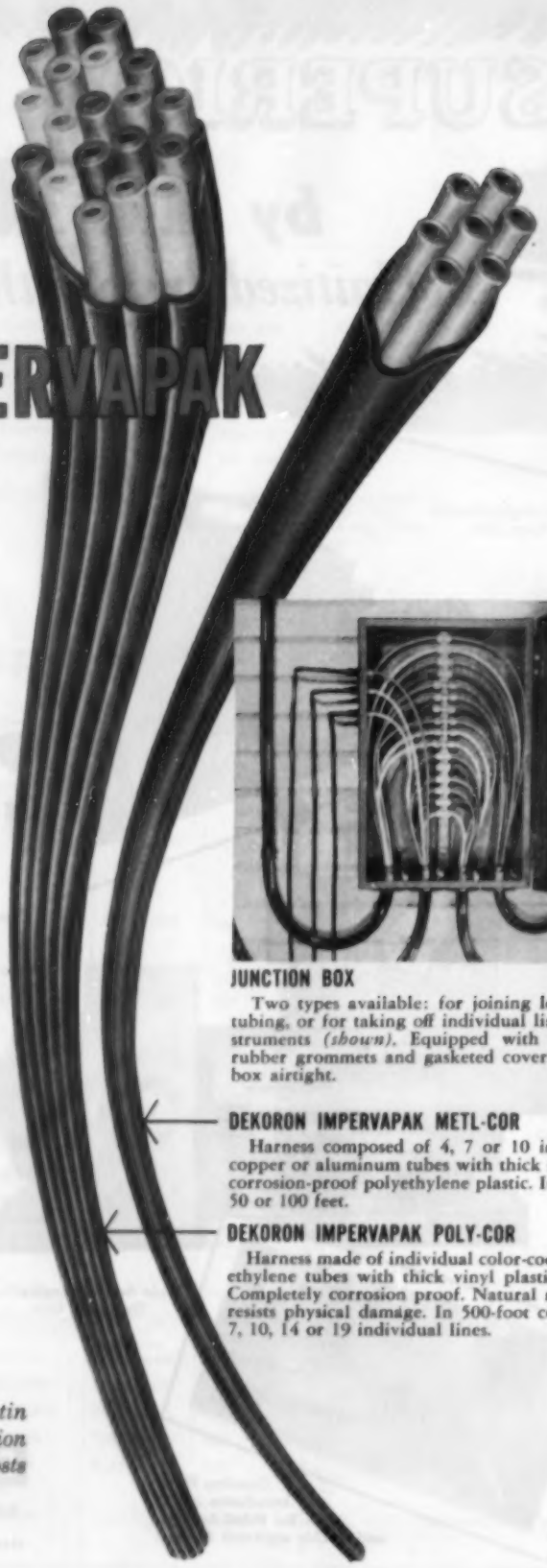
DEKORON IMPERVAPAK

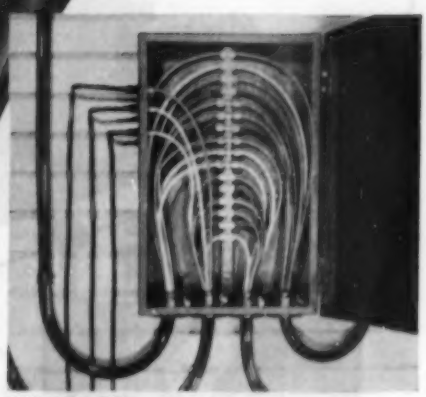
the instrument line harness that cuts tubing installation costs up to 80%

Worried about high instrument tubing installation costs? Then Dekoron Impervapak—the chemically resistant instrument tubing harness—is just what the cost analyst ordered.

With Dekoron Metl-Cor or Poly-Cor you don't laboriously install instrument lines one at a time. As many as 19 tubes can be installed at one handling—that's why users report that Metl-Cor cuts costs up to 60%, Poly-Cor up to 80%. Compact construction further reduces racking costs, looks neater and resists mechanical damage.

And perhaps most important of all, *Dekoron Impervapak is impervious to attack from even the most severe industrial atmospheres or weather conditions.* AA-144





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Two types available: for joining lengths of tubing, or for taking off individual lines to instruments *(shown)*. Equipped with synthetic rubber grommets and gasketed cover to make box airtight.

DEKORON IMPERVAPAK METL-COR

Harness composed of 4, 7 or 10 individual copper or aluminum tubes with thick sheath of corrosion-proof polyethylene plastic. In coils of 50 or 100 feet.

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Harness made of individual color-coded polyethylene tubes with thick vinyl plastic sheath. Completely corrosion proof. Natural resiliency resists physical damage. In 500-foot coils of 4, 7, 10, 14 or 19 individual lines.

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REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
*Royalite Oil Co.	Colville, Sask.	Vacuum Unit	3,800 bbls.	$170,000	Under Constr.	June 30, 1955		Caribou Eng. Co., Ltd.	Company Construct.
Shell Oil Co.	Okotoks, Alberta	Sulfur Ext. Plt.			Planned				
*Shell Oil of Canada	Montreal, East	Increase Cat. Cracking, Vacuum Flasher	10,500 bbls.	$4,000,000	Under Constr.	Late, 1955		Staff	McKee
*Shell Oil Co. of Canada	Vancouver, B.C.	Platformer	3,300 bbls.	$1,500,000	Planning (Unconfirmed)	Late, 1955			
Sherritt-Gordon Mines, Ltd.	Fort Saskatchewan, Alta.	Anhydrous Ammonia	75 tons	$24,000,000	Planned				
*Standard Oil Co. of of British Columbia	Vancouver, B.C.	Refinery Expan.	†18,000 bbls.	$2,500,000	Under Constr.	Late, 1955			
Texaco Oil Co.	Edmonton, Canada	Gas Absorp. Plt.		$6,000,000	Under Constr.				
Wainwright Producers & Refiners, Ltd.	Edmonton, Alberta, Canada	Cap. Inc.	†2,300 bbls.		Under Constr.			Treco	Treco
LATIN AMERICA									
Argentina									
*Conselho Nacional do Petroleo	Mataripe	Refinery Expan.	†15,000 bbls.		Planning (Unconfirmed)				
*Esso Refinadora Petroleo, S.A.	Argentina	Lubricating Oil Plt.	375,000 bbls. a year		Planning (Unconfirmed)				
Yacimentos Petroliferos Fiscales (ENDE)	Cerro Bandera P. Huincul Neuquen	Dehydration Plt.	10,400 bbls.		Under Constr.	1955		Y.P.F.	Y.P.F.
Brazil									
Companhia de Petroleo de Amazonia	Manaus	Refinery; Cat. Crker. & Aux. Units	5,000 bbls.	$4,000,000	Engineering	Late 1955	U.O.P.	Sweco	Sweco
Conselho Nacional do Petroleo	Bahia	Lube Oil Fac. Expansion	2,000 bbls. 10,000 bbls.	$12,000,000	Planned				
Conselho Nacional do Petroleo	Cubatao	Anhydrous Ammonia	100 tons		Under Constr.	Late 1955	Texaco Dev.	Foster Wheeler	Foster Wheeler
Conselho Nacional do Petroleo	Cubatao, Sao Paulo	Expansion	30,000 bbls.		Planned				
*Companhia Brasiliera de Estireno	Cubatao	Styrene Monomer Plt.			Engineering		Koppers, Firestone	Koppers	Koppers
*Petroleo Brasileiro, S.A.	Brasil	Asphalt Plt.	3,500 bbls.		Planning			Southwestern Standard (Calif.)	Southwestern
*Petroleos Mexicanos	Salamanca	Lubrocrat Plt.	†2,500 bbls.	$15,000,000	Planning (Unconfirmed)				
Colombia									
Colombian Petro-Company	Barco Concession	Gas Treating Plt.	2,000 bbls.	$5,000,000	Under Constr.				
International Petroleum (Columbia), Ltd.	Cartagena	Refinery	25,000 bbls.	$35,000,000	Planned	Late 1957			
Mexico									
Petroleos Mexicanos	Arbol Grande Tamaulipas	Improvements			Engineering	1955		Staff	Staff
Petroleos Mexicanos	Ciudad Madero Tamulipas	Enlarge, Modern-Feed prep. Cat. Crker. Fluid-coker, Offsite	100,000 bbls.	$30,000,000	Planned	Early 1957			
Petroleos Mexicanos	Reynosa	Absorption Plt.	300 Mmcf	$10,000,000	Under Constr.	2nd Qtr., 1955		Hudson	Staff
Petroleos Mexicanos	Reynosa	Enlarge Topping Unit Thermal Cracking	5,000 bbls. 2,000 bbls.		Engineering	Late 1955	U.O.P.	Staff	Staff
*Petroleos Mexicanos	Salamanca	Lube Oil Fac., Wax Plt.		$25,000,000	Complete				
Petroleos Mexicanos	Poza Rica, Ver.	Expan. Gas Absorption purification, Water and Gas Repressuring	120 Mmcf	$20,000,000	Complete			McKee	Staff
*Petroleo Mexicanos	Mata Redonda	Refinery Expan.			Planning (Unconfirmed)				
Petroleos Mexicanos	Minatitlan	Topping, Feed Prep., TCC Cat. Crker., Poly. Offsite	25,000 bbls.	$12,000,000	Under Constr.	3rd Qtr., 1955	Socony, U.O.P.	Fluor	Staff
Petroleos Mexicanos	Mexico, D. F.	Cap. Increase	50,000 bbls.	$12,000,000	Under Constr.	3rd Qtr., 1955		McKee	Staff
Petroleos Mexicanos	Pacific Coast	Refinery	30,000 bbls.		Planned				
*Petroleos Mexicanos	Tampico	Refinery Expan.			Planning (Unconfirmed)				
Netherlands Antilles									
*N.V. Bataafsche Petroleum Maatschappij	Curacao	Vacuum Still	66,000 bbls.			1956		S & W. Badger Div.	
N. V. Curacaosche Petroleum Industrie Maatschappij	Curacao	Cat. Crker.	35,000 bbls.	Part of $56,000,000 Project	Planned	End, 1957			
Peru									
*Helios, S.A.	San Andres	Fertilizer Plt.	130,000 tons		Planning (Unconfirmed)				
Helios, S.A.	Sao Andrus	Lube Oil; Asphalt Refinery	60,000 tons lube oil; 10,000 tons Asphalt/yr.	$8,000,000	Projected	Early 1956		Hydrocarbon	
Puerto Rico									
*Americo Rodriques Co.	San Juan	LPG PH	12,000 bbls.		Under Constr.			Fluor	Fluor
Caribbean Refining Co.	San Juan	Refinery	10,000 bbls.	$11,000,000	Under Constr.		U.O.P.	Fluor	Fluor
Commonwealth Oil Refining Co.	Guayanilla Bay	Refinery: Houdriflow Cat. Crker. Houdriformer	25,000 bbls. 26,800 bbls. 3,730 bbls.	$25,000,000	Under Constr.			Lummus	Lummus
Venezuela									
Compania Shell de Venezuela	Cardon	Cat. Crker.	35,000 bbls.	Part of $56,000,000 Project	Planned	End, 1957			
Creole Petroleum Corp.	Amuay	Fluid Hydro-former	10,000 bbls.		Complete		S.O.D.	S.O.D.	Foster Wheeler
Creole Pet. Corp.	Amuay Bay	Vac. Pipestill	42,000 bbls.	$7,000,000	Complete			Foster Wheeler	Foster Wheeler
Socony-Vacuum Oil Co. of Venezuela	Puerto Cabello	Refinery			Planned (Unconfirmed)				
*N.V. Bataafsche Petroleum Maatschappij	Cardon	Vacuum Still	66,000 bbls.			1956		S & H Badger Div.	

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
*Venezuelan Government	Puerto La Cruz	Petrochemical Plt.	.....	.....	Planning (Unconfirmed)	.....	.....	.....	.....
EUROPE AND AFRICA									
Belgium									
Societe Industrielle Belge des Petroles	Antwerp	Cat. Crker.	10,000 bbls.	$10,000,000	Under Constr.	1st Qtr., 1955	U.O.P.	Lummus	Lummus
S.I.B.P.	Antwerp	Cat. Poly. Unit	3,000 bbls.	.....	Complete	.....	U.O.P.	Lummus	Lummus
Denmark									
A. P. Moeller	Copenhagen	Refinery	.....	$11,500,000	Planning (Unconfirmed)	.....	.....	.....	.....
Egypt									
*Egyptian Government	Alexandria	Refinery	.....	.....	Planning (Unconfirmed)	.....	.....	.....	.....
Egyptian Government	Cairo	Refinery	20,000 bbls.	.....	Planning	.....	.....	Lummus	Lummus
Egyptian Government	Suez	Inc. Refn Cap.	26,000 bbls.	$24,000,000	Planning	.....	.....	.....	Lummus
England									
Berry Wiggins & Co., Ltd.	Weaste Ref., Manchester, Ship Canal	Extension to Refinery	500 bbls.	.....	Under Constr.	.....	.....	H.W.P.	H.W.P.
*British Petroleum Chemicals, Ltd.	Grangemouth	Detergent Alkylate Plt.	35 tons	.....	.....	1955	California Research	S & W Badger Div.	E. B. Badger & Sons, Ltd.
‡British Petroleum Co., Ltd.	Kent	Vacuum Unit	17,000 bbls.	.....	Complete	.....	.....	E. B. Badger, Ltd.	E. B. Badger, Ltd.
Esso Petroleum Co.	Fawley	Refinery Expan. Including Hydroforming Unit	135,000 bbls.	.....	Under Constr.	.....	.....	.....	.....
*Imperial Chemical Industries	Wilton	Chemical Plt.	30 tons	.....	.....	1956	.....	S & W Badger Div.	E. B. Badger & Sons, Ltd.
*Imperial Chemical Industries	Billingham,	Expan. to Mfg. Alcohols by Carbonylation	140,000 tons/yr.	.....	Engineering	End, 1956	.....	Staff	.....
Imperial Chemical Industries	Wilton	Terylene Plt.	22 mln. lbs./yr.	$50,000,000	Nearing Completion	1955/1956	.....	.....	.....
Imperial Chemical Industries	Wilton	Butadiene Separation Plt.	6/7000 ton/yr.	.....	Design	.....	.....	H.W.P.	.....
*Imperial Chemical Industries	Wilton	Extension of Cracker	1250,000 tons/yr.	.....	Under Constr.	3rd Qtr., 1956	.....	Staff and Kellogg	Kellogg
Monsanto Chemicals, Ltd.	Britain	Add Polystyrene	.....	.....	Under Constr.	.....	.....	Staff	Staff
Monsanto Chemicals, Ltd.	Britain	Styrene-Butadiene Copolymer Plt.	4,000 tons/yr.	$14,000,000	Planned	.....	.....	.....	.....
Shell Refining & Marketing Co.	Stanlow	Hydrodesulfurization	5,200 bbls.	.....	Under Constr.	Early 1955	.....	.....	.....
Shell Refining & Marketing Co.	Stanlow	Isopentane Plt.	.....	$1,400,000	Under Constr.	Early, 1955	.....	H.W.P.	.....
Shell Refining & Marketing Co.	Shell Haven	Cat. Reformer	6,700 bbls.	.....	Under Constr.	End, 1955	.....	.....	.....
Shell Refining & Marketing Co.	Stanlow	Extension to Distilling Plt.	I.P.A. 67 tons S.B.A. 102 tons	.....	Complete	.....	.....	H.W.P.	.....
Finland									
Finnish Government	Finland	Refinery	9,000 bbls.	.....	Planning (Unconfirmed)	.....	.....	.....	.....
*Neste Corp.	Turku, Finland	Refinery	14,000 bbls.	$17,500,000	Planning (Unconfirmed)	.....	.....	.....	.....
France									
Compagnie de Raffinage Shell-Berre	Petit Gouronne	Cat. Crker.	8,000 bbls.	.....	Under Constr.	Mid 1956	.....	.....	.....
Comp. Francaise de Raffinage	Gonfreville	Refinery Expan.	.....	.....	.....	.....	.....	.....	.....
*Houilleres du Bassin du Nord et du Pas-de-Calais	Bully-Les-Mines	Ethane Cracking Plt.	20 tons	.....	.....	1955	.....	S & W Badger Div.	.....
*Societe du Caoutchouc Butyl	Le Havre	Synthetic Rubber Plt.	20,000 tons/yr.	.....	Planning	.....	.....	.....	.....
*N. V. Batasfache Petroleum Maatschappij	Petit Couronne	Vacuum Still	33,000 bbls.	.....	.....	1955-56	.....	S & W Badger Div.	.....
Societe des Raffineries de Petrole de la Gironde	Ambes	Cat. Crker.	4,600 bbls.	.....	Engineering	1957	U.O.P.	U.O.P.	Lummus
		Vacuum Unit	6,300 bbls.	.....	Engineering	1956	.....	Lummus	Lummus
Societe des Raffineries de Petrole de la Gironde	Ambes	Poly Plt.	540 bbls. (Product)	.....	Engineering	1956	C.R.C.	Foster Wheeler	Lummus
West Germany									
*Chemische Werke Huels, A.G.	West Germany	Synthetic Rubber Plt.	.....	.....	Considering	.....	.....	.....	.....
Badische Anilin & Soda Fabrik, A.G. & Deutsche Shell	Wesseling Area	Polyethylene & Ethylbenzene plt	.....	.....	Projected	1955	.....	.....	.....
*Clewerkschaft Erdoel Raffinerien Emsland	Lingen	Houdriformer	3,500 bbls.	.....	Planning	End, 1955	Houdry	Lummus	Lummus
Kali Chemie Co.	Neinberg	Bead Catalyst Plt.	.....	.....	Licensed	.....	Soc.-Vac.	.....	.....
Greece									
Greek Government	Piraeus	Refinery	30,000 bbls.	$15,000,000	Under Constr.	Jan., 1957	.....	Armistead	Hydro. M
Italy									
*Ente Nazionale Idrocarburi	Ravenna	Butadiene Plt.	30,000 tons a yr. Rubber	75,000,000	Planning	.....	.....	Union Carbide Carbon;	.....
		Copolymer Plt.	350,000 tons a year, Nitrogen Fertilizers		Planning	.....	.....	Phillips Petroleum	.....
*Azienda Generale Italiana Petroli	Venice	Platformer	1,750 bbls.	.....	Planning (Unconfirmed)	.....	.....	.....	.....
*Azienda Generale Italiana Petroli	Cagliari	Refinery	500,000 tons	.....	Planning (Unconfirmed)	.....	.....	.....	.....
*Gullo Industria Petrolifera S.P.A.	Gaeta, Italy	New Refinery Topping, Catalytic Reforming Viscosity Breaking Vacuum Distillation	15,000 bbls.	.....	.....	.....	.....	Tecnider	.....
I.L.S.E.A.	Valmadrera, Como	Cat. Reforming Unit	500 bbls.	.....	Under Constr.	Spring, 1955	Atlantic	Tecnider	Tecnider
Industria Raffinazione Olii Minerali	Venice	Platformer	2,000 bbls.	.....	Planned	1st. Qtr., 1956	U.O.P.	Procon	C.T.I.P.

‡ Formerly Anglo-Iranian Oil Co.

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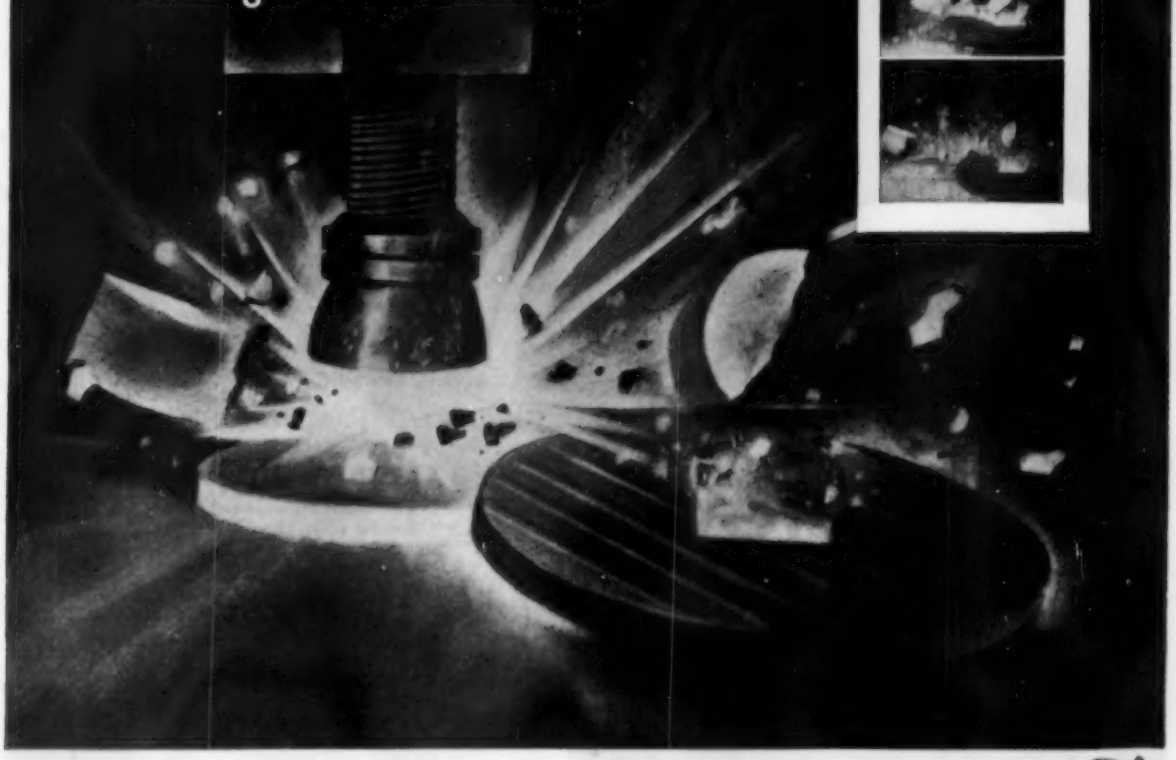

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Granules • Rings, and Flakes

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REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Italia, S.P.A.	Cremona, Italy	Catformer	800 bbls.		Under Constr.	July, 1955	Atlantic	Tecnider	Tecnider, Anaklo
Montecatini	Barranca Bermeja	Anhydrous Ammonia Plt.	50 tons		Planning (Unconfirmed)				
*Purfina Italiana, S.P.A.	Genoa	Platformer	1,000 bbls.		Planning (Unconfirmed)				
*Purifina Italiana, S.P.A.	Milan	Distillation Unit	†5,000 bbls.		Planning (Unconfirmed)				
Societa Per Azioni Raffinerie Padane Olii Minerali (SARPOM)	San Martino di Trecate (Novara)	Cat. Crker.	2,880 bbls.		Under Constr.	1955	U.O.P.	U.O.P., E. B. Badger, Ltd.	S&W Badger Div.
		Vacuum Unit	5,150 bbls.		Under Constr.	1955		S&W Badger	S&W Badger Div.
		Poly. Plt.	315 bbls.		Under Constr.	1955	C.R.C.	Foster Wheeler	S&W Badger Div.
*'Societa' Petrolifera Italiana S.P.I.	Fornovo Taro (Parma) Italy	Hydrotreating	1,000 bbls.		Under Constr.	May, 1955	Staz. Sperimentale per i Combustibili Milano	Tecnider	Tecnider Staff
Socony-Vacuum Italiana, S.P.A.	Naples	Cat. Poly.		$724,000	Under Constr.	2nd Qtr , 1955	Calif. Res.	Mediterranean Builders, Inc.	C.T.I.P.
Socony-Vacuum Italiana, S.P.A.	Naples	TCC			Under Constr.	2nd Qtr., 1955	Soc.-Vac.	Mediterranean Builders, Inc.	C.T.I.P.
Netherlands									
Caltex Petroleum Maatschappij (Nederland) N.V.	Pernis	Platformer	7,000 bbls.		Engineering	1957	U.O.P.	Lummus, Ltd.	Lummus-Werkspoor
		Desulfurization	4,000 bbls.		Engineering	1957	U.O.P., Union	Lummus, Ltd.	Lummus-Werkspoor
*Nederlandsche Dow Maatschappij N.V.	Rotterdam	Petrochemical Plt.			Planned				
*N. V. de Bataafsche Pet. Maatschappij	Pernis	Vacuum Still	66,000 bbls.		Under Constr.	1955-56		S&W Badger Div., E. B. Badger, Ltd.	
N. V. Bataafsche Petroleum Maatschappij	Pernis	Luboil Ref. Exp.	1,780 bbls.		Under Constr.	Early, 1955			
N. V. de Bataafsche Petroleum Maatschappij	Pernis	Cat. Crker.	33,000 bbls.		Under Constr.	Mid 1956			
Scotland									
British Petroleum Chemicals, Ltd.	Grangemouth	Alkylate Plt.			Planning (Unconfirmed)				
Spain									
*Instituto Nacional de Industria	Cartagena	Refinery Expan.	†70,000 bbls.		Planning (Unconfirmed)				
Refinería de Petroleos de Escombreras S.A.	Escombreras	Lube Oil Plt.	27,500 net tons/yr.		Complete			Foster Wheeler	Foster Wheeler
		Crude Unit	23,000 bbls.		Engineering	1956		Foter Wheeler	
		Platformer	5,000 bbls.		Engineering	1956		U.O.P., Foster Wheeler	
Sweden									
*Johnson Line, Stockholm Shipping Firm	Gothenburg	Refinery	2,500 bbls.		Planned			Staff	Staff
Trieste									
S.P.A. Tecnico Industriale Aquila	Trieste	Cat. Cracking	3,300 bbls.		Under Constr.		Soc.-Vac.	Staff	Staff
S.P.A. Tecnico Industriale Aquila	Trieste	Cat. Poly.	1,400 bbls.		Under Constr.		U.O.P.	Staff	Staff
Turkey									
Turkish Government	Kutahya	Nitrogen Plt.			Projected				
Turkiye Petrolleri A.O.	Batman	Refinery	6,950 bbls.	$10,000,000	Under Constr.	Mid 1955		Parsons	Parsons
Union of South Africa									
Anglo-Transvall Consolidated Investment Co.	Vaal River	Synthetic Gaso. & Diesel Oil Plt.		$50-60,000,000	Contracted				
*Shell Oil Co.	Island View	Lube Oil Plt.		$1,960,000	Planning (Unconfirmed)				
South Africa Coal Oil & Gas	Coalbrook, Orange Free State	Plt. Expansion	3,500 bbls.	$50,400,000	Completing	April, 1955			
Union Petrol Refinery, Ltd.	Johannesburg	Refinery		$20,000,000	Projected				
Wales									
National Oil Refineries, Ltd.	Llandarcy	Platformer	6,000 bbls.	$3,000,000	Under Constr.	2nd Qtr., 1956	U.O.P.	Procon (G.B.)	E. B. Badger, Ltd.
Yugoslavia									
*Yugoslavia Government	Makarska	Refinery			Planning (Unconfirmed)				
NEAR EAST									
Bahrain									
Bahrain Petroleum Co., Ltd.	Bahrain	Vacuum Still	23,000 bbls.		Under Constr.	1955		Lummus	Foster Wheeler
Bahrain Petroleum Co., Ltd.	Bahrain	Cat. Crker.	18,000 bbls.		Engineering	1957		Foster Wheeler	Foster Wheeler
		Poly Plt.	1,500 bbls.		Engineering	1956		Foster Wheeler	Foster Wheeler
		Vacuum Still	23,000 bbls.		Under Constr.	1956		Lummus	Foster Wheeler
Iraq									
Iraq Government	Dora	Lube Oil Plt.	25,000 tons/yr.		Planned (Unconfirmed)				
	Dora	Asphalt Plt.			Considering				
Israel									
Fertilizers & Chemicals	Haifa	Hydrogen, Ammonia, Sulfuric Acid, Nitric Acid, Ammonia Sulfur, Ammonia Nitrate		$15,000,000	Complete			Chemico	Staff
Kadimah Chemical Corp.	Haifa	Detergent Mfg.	10 tons	$500,000	Complete				Staff
Jordan									
Jordanian Reconstruction Council	Mafrak	Refinery		$7,500,000	Planned				
Lebanon									
Mediterranean Refining Co.	Sidon	Refinery	6,000 bbls.		Complete		U.O.P.	Bechtel Assn., Procon	Bechtel Assn.
*Mediterranean Refinery	Sidon	Refinery Expan. (Increase Crude Unit; Second Platformer)	†9,000 bbls.		Under Constr.	End, 1955	U.O.P.	Bechtel Assn., Procon	Bechtel Assn.
Saudi Arabia									
*Arabian American Oil Co.	Ras Tanura	Asphalt Plt.	1,250 bbls.		Planning (Unconfirmed)	1956			

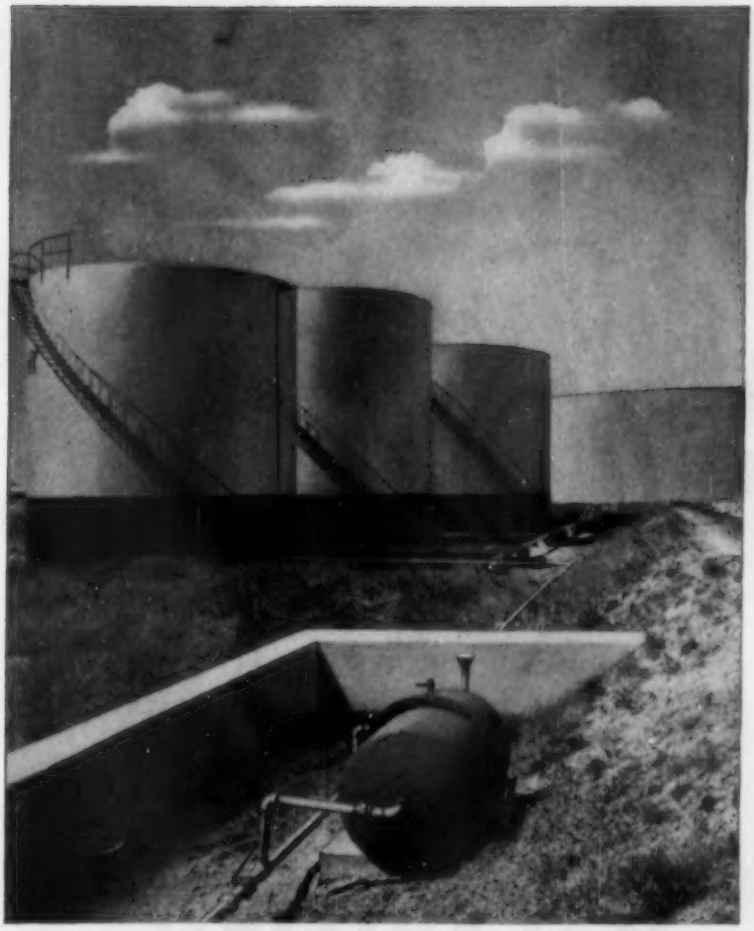
REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Arabian American Oil Co.	Ras Tanura	Fluid Cat. Hydroformer	12,500 bbls.	$9,925,000	Under Constr.	Jan., 1956	S.O.D.	Lummus	Lummus
Saudi Arabian Government	Saudi Arabia	Ammonium Sulfate Plt.	400,000 Metric tons/yr. Plus 500 Tons Dry Ice	.....	Proposed	.....	.....	.....	.....
FAR EAST									
Borneo									
British Malayan Petroleum Co., Ltd.	North Borneo	Nat. Gasc. Plt.	2,125 bbls.	.....	Complete	.....	.....	.....	.....
Burma									
Burma Oil Co.	Chauk	Distil. Unit	2,500 bbls.	.....	Under Constr.	.....	.....	.....	.....
Ceylon									
Ceylon Government & Shell Co. of Ceylon, Ltd.	Hendala	Refinery	.....	$40,000,000	Negotiating	.....	.....	.....	.....
India									
Burmah-Shell Refineries, Ltd.	Bombay	Refinery	40,000 bbls.	$47,000,000	Complete	.....	.....	.....	.....
Caltex Oil Refining (India) Ltd.	Visakhapatnam	Refinery	13,500 bbls.	.....	Under Constr.	1957	.....	Lummus Foster Wheeler Ewbank & Tardrese	Lummus
*Indian Government	India	Synthetic Petroleum Plt.	6,000 bbls.	.....	Planning	.....	.....	.....	.....
Standard Vacuum Oil Co.	Trombay	Refinery	.....	.....	Complete	.....	.....	.....	.....
Japan									
Daikyo Oil Co., Ltd.	Yokkaichi	Houdriflow & Cat. Poly.	3,500 bbls.	.....	Under Constr.	Early, 1955	Houdry & Calif. Res.	Houdry	.....
Idemitsu Kosan Co.	Tokuyama	Refinery	18,000 bbls.	.....	Planning (Unconfirmed)	.....	.....	.....	.....
Mitsubishi Oil Co., Ltd.	Tokyo	Vac. Distl. Unit	2,000 bbls.	.....	.....	.....	.....	.....	.....
Nippon Petroleum Refining Co., Ltd.	Yokohama	Modern. and Expansion	12,000 bbls.	.....	Under Constr.	1955	.....	McKee	McKee
Showa Oil Company	Tokuyama	Refining Fac.	.....	.....	Planning	.....	.....	.....	.....
Showa Oil Company	Tokuyama	Petrochemicals	.....	.....	Planning	.....	.....	.....	.....
Showa Oil Company	Hiraswa	Alkyl Sulfonate	2 tons (Pilot Plt.)	.....	Testing	.....	.....	.....	.....
*Korean Government	Korea	Urea Fertilizer Plt.	80,000 tons/yr.	$25,000,000	Planning	Mid-1957	.....	.....	.....
Pakistan									
Pakistan Petroleum, Ltd.	Baluchistan, W. Pakistan	Gas Processing Plt.	.....	$30,000,000	Planning (Unconfirmed)	May, 1955	.....	Hudson	Hudson
Sumatra									
Standard Vacuum Refinery	Sumatra	Refinery Mod.	.....	.....	.....	.....	.....	Foster Wheeler	Foster Wheeler
Taiwan									
Chinese Petroleum Corp.	Kaohsiung (Formosa)	Thermofor Cat. Crker.	10,000 bbls.	.....	Under Constr.	2nd Qtr., 1955	Soc.-Vac.	Fluor	Fluor
		Cat. Reformer	3,100 bbls.	.....	Under Constr.	2nd Qtr., 1955	Atlantic	Blaw-Knox	Blaw-Knox
Taiwan Fertilizer, Ltd.	Nankong	Ammonia Plt. to Produce Urea	200 tons	.....	Design Stage	1956	Vulcan	NH_3-Hydrocarbon Urea—Vulcan	Hydrocarbon
AUSTRALASIA									
Australia									
Australian Oil Refining, Ltd.	Kurnell	Refinery	22,000 bbls.	.....	Under Constr.	1955	.....	S.&W. Badger Div., E. B. Badger, Ltd., Ewbank & Partners, Christiani and Nielson, Foster Wheeler	E. B. Badger Pty.
‡British Petroleum Co.	Kwinana	Refinery	60,000 bbls.	.....	Completing: Partial Operations	.....	.....	.....	Kellogg, Kellogg International, Costain-John Brown
Petroleum and Chemical Corp.	Silverwater	Petrochemical Plt.	.....	$7,000,000	Planned	Dec., 1955	.....	Power-Gas Corp. (Aust) Pty., Ltd.	Power-Gas Corp. (Aust) Pty., Ltd.
Shell Refining (Australia) Proprietary, Ltd.	Geelong	Cat. Crker.	12,000 bbls.	.....	Under Constr.	Mid., 1955	.....	.....	.....
Socony-Vacuum	Altona	Alkylation Unit	1,700 bbls.	.....	Planned	Aug., 1956	.....	.....	.....
Standard-Vacuum Refining Co., Ltd.	Melbourne	Refinery Expan.	25,000 bbls.	$30,000,000	Nearing Completion	.....	.....	Braun, Soc.-Vac.	Braun
Philippine Islands									
Caltex (Philippines, Inc.)	Batangas	Refinery	13,000 bbls.	.....	Complete & On Stream	.....	.....	Foster Wheeler, McKee, Bechtel	Foster Wheeler

‡ Formerly Anglo-Iranian Oil Company.

* First appearance in tabulation † Added capacity

NOTE:
Armistead—George Armistead & Co.
Atlantic—Atlantic Ref. Co.
Austin—Austin Co.
Badger Mfg.—Badger Manufacturing Co.
E. B. Badger Ltd.—E. B. Badger & Sons Ltd.
E. B. Badger Pty.—E. B. Badger & Sons Pty., Ltd.
Barnes—W. M. Barnes Co.
Bechtel—Bechtel Corp.
Beck—Henry C. Beck
Blaw-Knox—Blaw-Knox Co.
Braun—C. F. Braun Co.
Brown & Root—Brown & Root Construction Co.
Buckner—F. J. Buckner Corp.
Calif. Res.—California Research Corp.
Can. Kellogg—Canadian Kellogg Co.
Cat. Constr.—Catalytic Construction Co.
Chemico—Chemical Construction Co.
Ch. Pro.—Chemical Process, Inc.
C. B. & I.—Chicago Bridge & Iron Co.
Chiyoda—Chiyoda Chemical Engineering & Construction Co., Ltd.
C. & I.—Chemical & Industrial Corp.
Consd. Eng.—Consolidated Engineering Company
Craig—A. F. Craig & Co.
C. T. I. P.—Compagnie Tecnica Industria Petroli
D & Z—Day & Zimmerman
Delta—Delta Engineering Corp.
Dresser—Dresser Engineering Corp.
Essco—Essco Services, Inc.
E&A—Ebrhart & Arthur, Inc.
Edeleanu—Edeleanu Gesellschaft M.B. H.
Etabadger, S.A.—Etablissement Badger, S.A.
Fish—The Fish Engineering Corp.
Ferguson—H. C. Ferguson Co.
Fluor—Fluor Corp.
Foster Wheeler—Foster Wheeler Corp.
Gas Plant Constr.—Gasoline Plant Const. Corp.
Girdler—The Girdler Co.
Graf—Graf Engineering & Equipment
Graver—Graver Construction Co.
Grebe & Dorenus—Grebe & Dorenus Process Co.
Gutte-Hutte—Gutehoffnungshuette
Hercules—Hercules Powder Co.
Hudson—Hudson Engineering Corp.
H.W.P.—Head Wrightson Process, Ltd.
Hydrocarbon—Hydrocarbon Research, Inc.
Hydro M.—Hydrocarbon Mineralocl G.m.b.H.
Hydro E.—Hydrocarbon Engineering S.A.R.L.
Kaiser—Kaiser Engineers
Kellogg—The M. W. Kellogg Co.
Kellogg P.A.—Kellogg Pan American
Koch—Koch Engineering Company
Koppers—Koppers Co., Inc.
Lummus—The Lummus Co.
Macco—Macco Corp.
McKee—Arthur G. McKee Co.
M-C & S—Merritt-Chapman & Scott Corp.
Olsen—O. L. Olsen
P. A. HydroRes—Pan-American Hydrocarbon Research Co.
Parker—Parker, Steffens & Pearce
Parsons—The Ralph M. Parsons Co.
Petco—Petroleum Engineering Tool Co.
Phillips—Phillips Petroleum Co.
Pritchard—J. H. Pritchard Co.
Procon—Procon, Inc.
Quaker—Quaker Valley Constructors
Russell—Russell Engineering Corp.
Refinery—The Refinery Engineering Co.
Rust—Rust Engr. Co.
S & B—Singmaster & Breyer Separator-Nobel Co.
Soc. Vac.—Socony-Vacuum Oil Co.
Southwestern—Southwestern Constr. Co.
S.O.D.—Standard Oil Development Co.
Sohio—Standard Oil Co. of Ohio
Stearns-Roger—Stearns-Roger Mfg. Co.
Sunland—Sunland Refining Co.
S & W Badger Div.—Stone & Webster Engineering Corp., Badger Process Div.
S & W Canada Ltd.—Stone & Webster Canada Ltd.
Sweco—Southwestern Engineering Co.
Texas—Texas Engineers
Tecnidor—Tecnica Idrocarburie Derivati
Tellepsen—Tellepsen Construction Co.
Texaco Dev.—Texaco Development Corp.
Texaco—The Texas Co.
Texas Natural—Texas Natural Gasoline Corp.
Treco—Refinery Engineering Co.
U.O.P.—Universal Oil Products Co.
Vulcan—Vulcan Copper & Supply Co.
J. G. White—J. G. White Eng. Corp



Shown in foreground is operating unit of Rockwood SpotPROTECTION System protecting oil storage at SOUTHWEST OIL REFINERY.

New Way to Protect a Danger Spot

The tank in the foreground is compact but powerful in action. It can stop a fire that could destroy a fortune.

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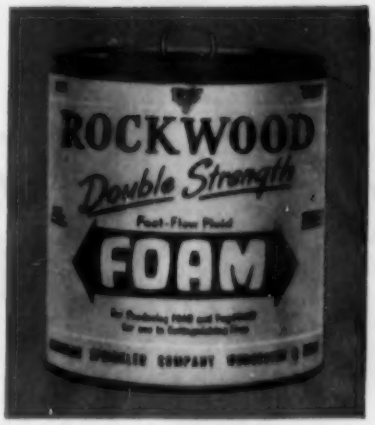
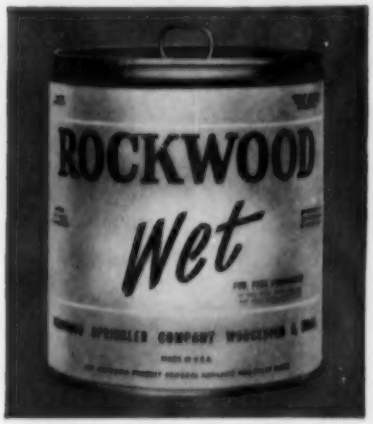
ROCKWOOD SPRINKLER COMPANY

Engineers Water . . . to Cut Fire Losses

How Rockwood Engineers Water to Cut Fire Losses



Rockwood Double Strength Foam clings to metal surfaces as an insulator, flows freely at sub-zero temperatures. Excellent for extinguishing fires in gasoline, benzol and other highly volatile liquids as well as ordinary combustibles.



Rockwood Wet makes water go farther. One part of Wet mixed with 99 parts water, increases penetration and extinguishing action of water. A "must" for deep seated fires and where water is scarce. Helps reduce amount of time and manpower.

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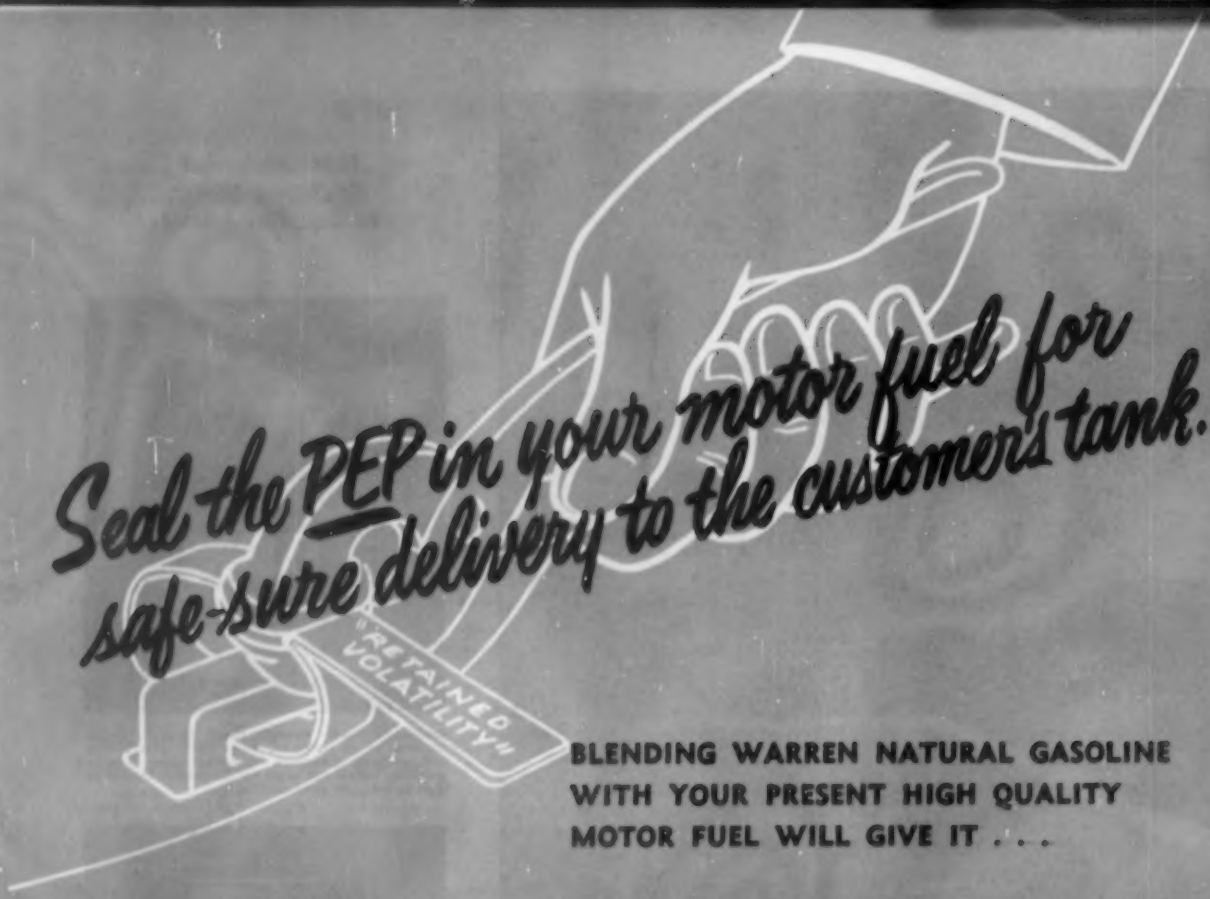

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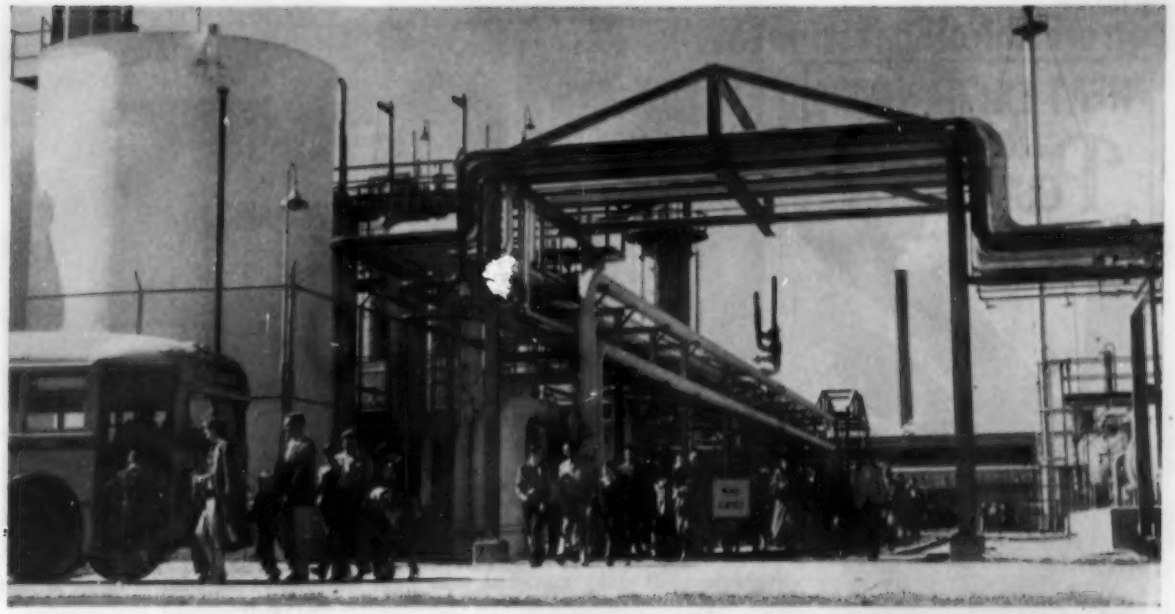

A group of guests board the plant bus after getting a close look at the process unit where ethyl alcohol is manufactured.

Where Dad Works

As Management Sees It . . .

The lunchroom was converted into a nursery. Refreshments were served. And more than 2000 people responded when Shell Chemical issued an invitation to come see . . .

Shell shift foreman explains operation of an automatic bagging machine in the EPON plant.

ON FIVE RECENT Saturdays, more than 2000 persons, members of employes' families, toured Shell Chemical Corporation's Houston plant in observance of "Plant Days."

The tours were designed to give families of Shell employes an opportunity to learn something of the plant where their husbands, fathers and relatives work. On the schedule each Saturday were visits to the plant's main office, warehouse, shops and first aid building, followed by a bus tour of the manufacturing area. Refreshments were served in the cafeteria. Employes served as guides each day.

For benefit of the small fry (and mother) the plant lunchroom was converted into a nursery under supervision of the plant nurses.

Each plant department had prepared exhibits showing what that particular group did, and how their activities were tied into those of other departments. One of the most popular was a display of products made at the plant with a description of their end uses. **See next page.**

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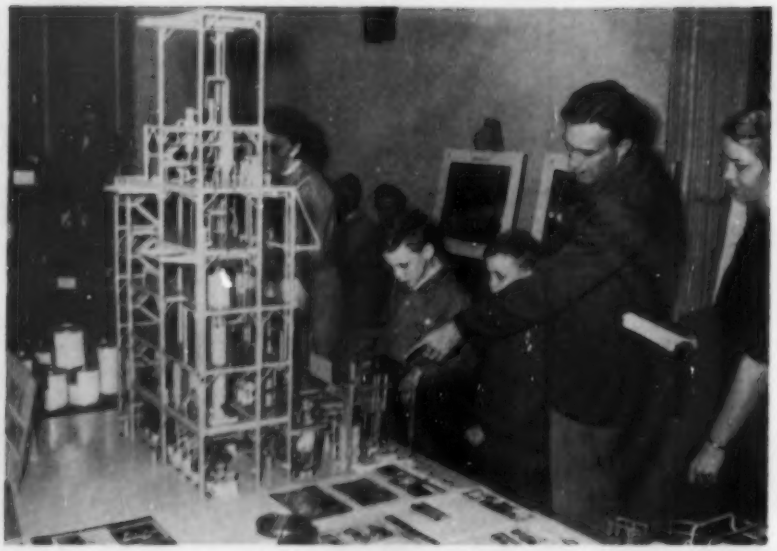
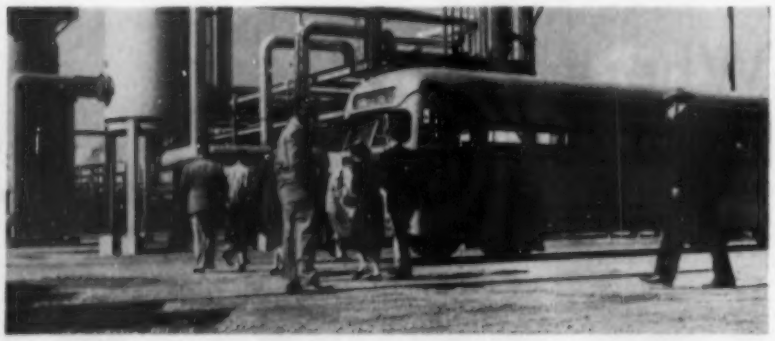
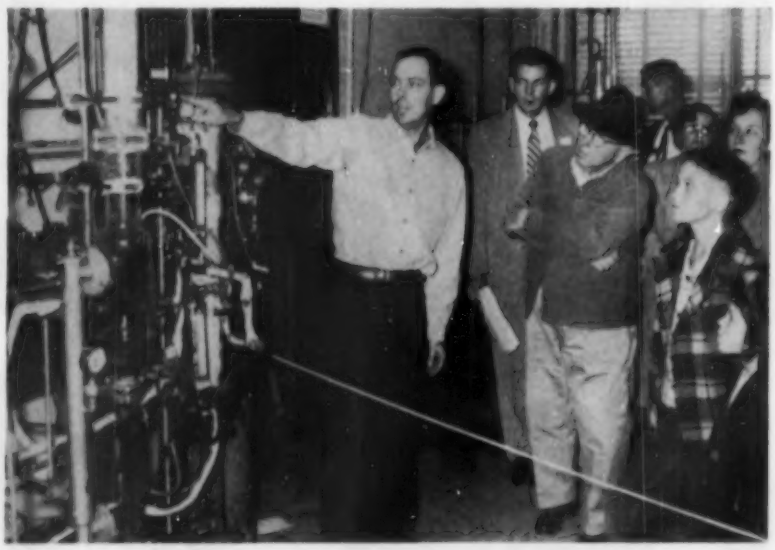


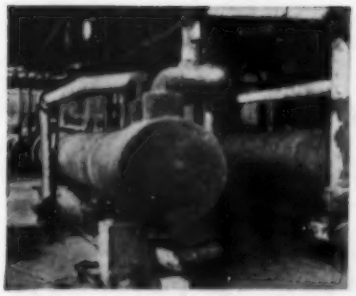
A scale model of the Bisphenol-A Plant proves interesting to one group of visitors at Shell Chemical's Houston plant. See Page 227.



Guests leave the bus to examine the process area where EPON resins are manufactured.

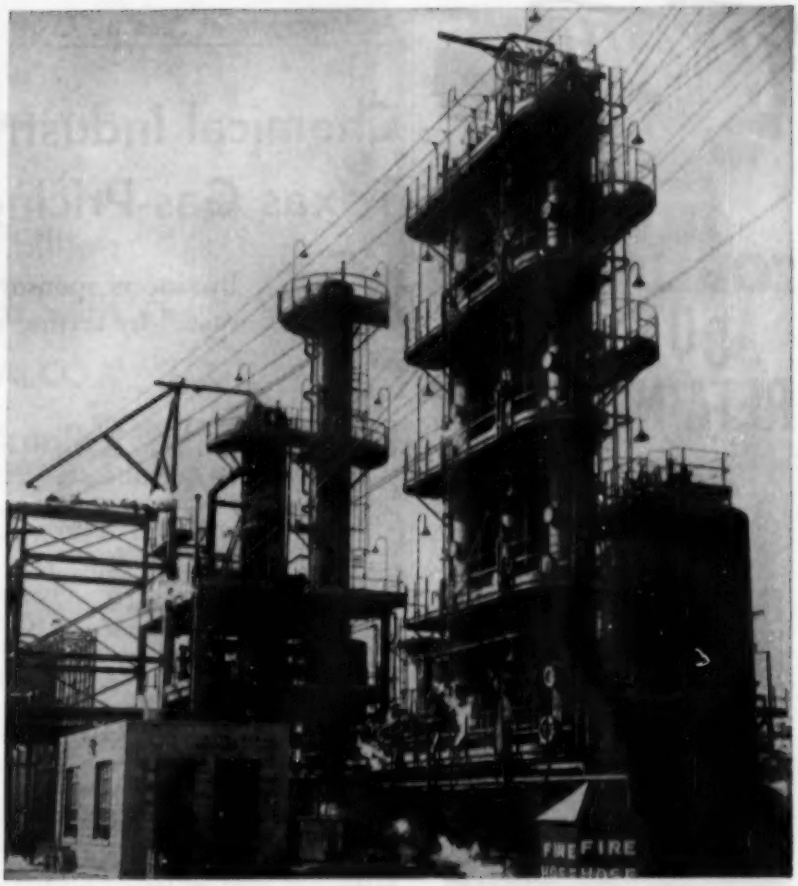


A Shell chemist acting as guide explains operation of a bench-scale process unit in the experimental laboratory.



Heat Exchange between pure caustic leaving the Unisol process regenerating tower and contaminated caustic entering, is accomplished in this all-Monel preheater.

Mercaptans are Steam-Stripped from Methanol-Caustic Soda Solution in this Unisol process regenerator tower at Atlantic Refining Company's Philadelphia refinery. Monel construction protects the tower, piping, preheater and reboiler from the extreme corrosiveness of the hot caustic solution.



When it's a question of caustic corrosion . . . refiners find Monel effective

Wax is Washed Free of Caustic with hot water in these agitator tanks at Atlantic Refining. Coned bottoms and sides to a height of six ft. are lined with Monel to withstand caustic corrosion.

Wherever caustic soda is used in hot or concentrated solutions, it is apt to create corrosion problems. Two such places in the refinery are:

1. Caustic regeneration in mercaptan removal processes.
2. Lube oil and wax treatment.

In both processes, Monel is widely used for equipment that must stand up under corrosion by hot caustic solutions.

In caustic regeneration, you find Monel used for the regenerating towers, and for pumps, piping, preheaters and reboilers. For parts where temperatures may reach or exceed 500°F., as in evaporator tubes, Inconel is to be preferred for its superior resistance to sulfide-containing caustics.

In the large outdoor agitators where hot wax is allowed to settle, then washed free of excess caustic left after neutralization processes, Monel linings have proven to be a satisfactory solution to the corrosion problem. Both nickel and Monel equipment are used to store caustic solutions. "S" Monel, with its excellent anti-galling properties is combined with Monel in hard-to-lubricate pumps to prevent seizing.

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

Have you a caustic soda corrosion (or purity) problem?
Then get in touch with Inco's Corrosion Engineering Section.
Write: International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

INCO Nickel Alloys

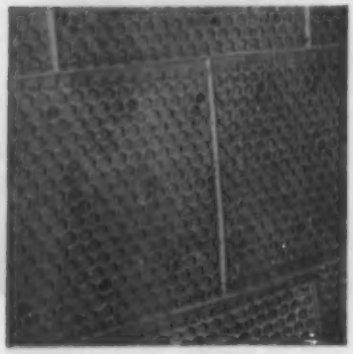
Monel . . . for minimum maintenance

For more data on advertised products, use Readers' Service Cards, last page.

RIGHT WHERE IT COUNTS!

IRVING "GRIDSTEEL" CONTOUR RETAINER MESH

Used with
Castable Ganister Linings
in Refractionating Units
in Petroleum
& Chemical Industries



RIGHT for

★ Thermal Cracking Units
★ Cyclones
★ Fluid Catalytic Regenerators
★ Fluid Catalytic Reactors
★ Hydroformers & Reactors
★ Flue-Gas Stacks & Ducts
★ Catalyst-Carrying Pipe Lines

REDUCE EXPENSIVE SHUTDOWNS
by using
Irving "GRIDSTEEL",
the quality contour retainer mesh.

IRVING SUBWAY GRATING CO., INC.
ESTABLISHED 1902

OFFICES and PLANTS at
5000 27th St., Long Island City 1, N. Y.
1800 10th St., Oakland 20, California

As Management Sees It . . .

Chemical Industry Fighting Texas Gas-Pricing Legislation

Producers sponsor bill aimed at prevention of "economic waste" by setting minimum prices.

The Economic Waste Bill received a severe setback April 4 when the House defeated by 82 to 53 a motion to bring it up for consideration out of its regular order. A two-thirds vote was needed. Because of the time element, it was considered highly unlikely that the measure will be passed during this session of the Legislature.

THE TEXAS chemical industry was standing this month in the perilous path of legislation designed to fatten the state treasury, aid independent producers, penalize pipe line companies, and ward off federal regulation.

Preliminary victories had been won in the Texas House by H.B. 7, an "economic waste statute" introduced by Rep. J. B. Walling of Wichita Falls and sponsored by the Texas Independent Producers and Royalty Owners Association.

The bill would authorize the Railroad Commission, upon application of any interested party, to determine the value of gas produced from any well or field in the state "to protect the correlative rights of owners to produce and market gas or to otherwise prevent discrimination and to protect the public interest . . ."

With TIPRO on one side and the chemical industry, pipe line companies and electric utilities on the other, the arguments swirled around these principal claims and charges:

For . . .

The bill will add $200 million a year to the income of independent producers and royalty owners. It will mean $16 million a year to the state treasury at a time when the Legislature is faced with the problem of raising another $30 million a year, not counting proposed spending for highways.

Taxes are now paid on an average basis of about 8.5 cents per thousand cubic feet. The figure most frequently mentioned by independent producers as a desirable minimum is 10 cents. The tax is now 9 percent of the market value at the well. It will go down to 8 percent on Sept. 1 unless the Legislature decides to devise its previous law providing for automatic reductions to 8 cents per mcf this September and 7 cents on Sept. 1, 1956.

Against . . .

The bill will raise the price of gas to the consumer.

Rep. Robert W. Baker of Houston charged: "The effect of this bill would be to take $200 million a year out of the pockets of consumers and put it in the pockets of already-rich members of TIPRO."

Rep. Guy Hazlett of Borger, cosponsor of the bill, disagreed, saying the consent of the governing authorities would be needed to pass along increases to public utilities.

J. M. Harris of Austin, attorney for the state's largest electric utilities, said the companies he represents had become so wary of legislative action that every major power company decided six or eight years ago to write an automatic pass-on clause into sales contracts. He said the price hike intended under the Walling proposal would be reflected within a month or two by household electricity bills.

TIPRO President Jack Woodward declared that the producer receives only 10 percent of the money paid for gas by a residential user. The remainder goes for transportation and processing.

Hayden W. Head, Austin attorney, spoke for Celanese Corporation of

9 years with the right desiccant... Sinclair dries 8.3 billion cubic feet of gas with one charge of ALCOA Activated Alumina

In nine years of continuous operation, this Wertz dehydrator charged with ALCOA Activated® Alumina has satisfactorily dehydrated over 8 *billion* cubic feet of gas, operating at 200 psi gage at 75°F to 90°F. The gas is then compressed to approximately 2,000 pounds.

Sinclair's objectives in treating the gas with ALCOA Activated Alumina are twofold: (1) to reduce or completely stop hydrate formation in the discharge from the compressor to the wells; (2) to completely dehydrate in order to reduce corrosion, since the gas contains moisture, carbon dioxide and hydrogen sulphide.

At an inspection of the lines and equipment in use during this nine-year operation, Sinclair found virtually no corrosion . . . proof again of the value and effectiveness of dehydration.

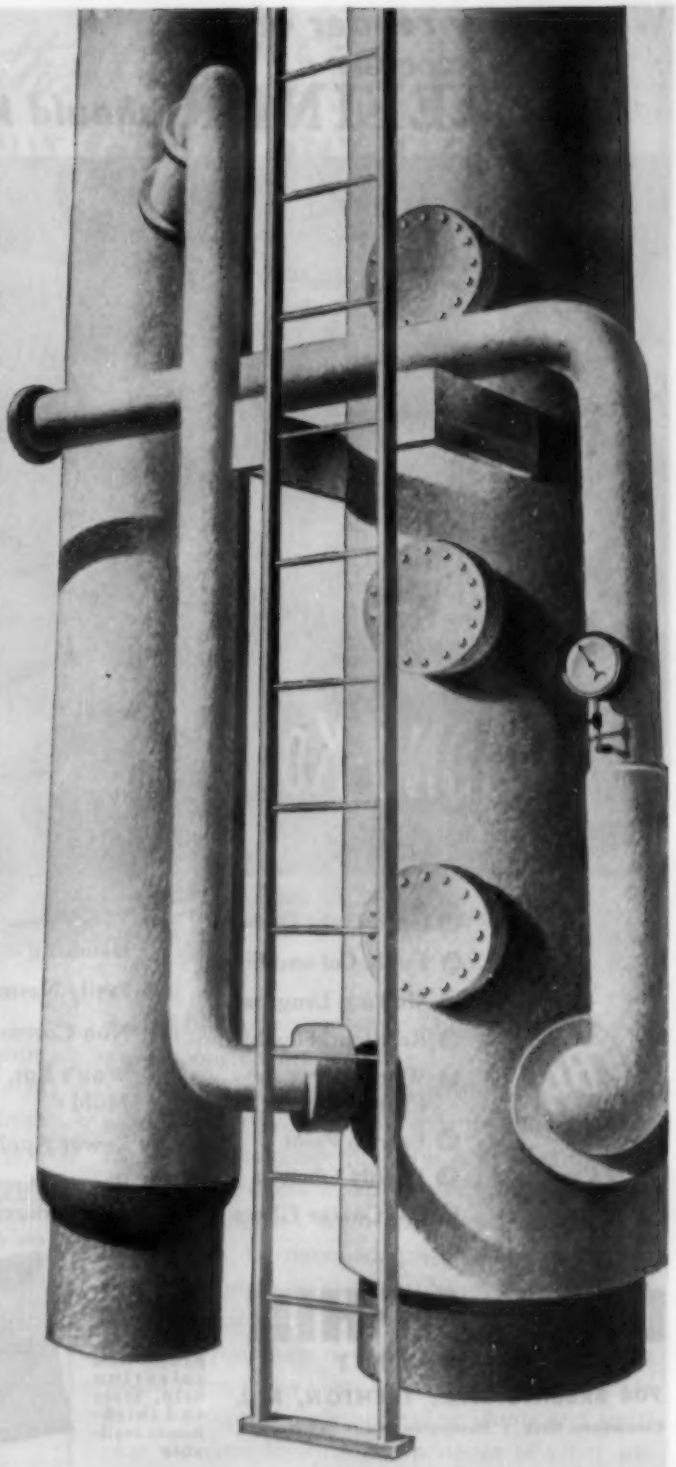
ALCOA Activated Alumina dries liquids, gases, air and gaseous hydrocarbons to *lower* dew points than any other commercial desiccant. It has extremely long life on the job because it does not swell, soften or disintegrate due to liquid water. Furthermore, ALCOA Activated Alumina is chemically inert to most gases and liquids, is noncorrosive and nontoxic.

If moisture is costing you money, why not find out how ALCOA Activated Alumina can *dry up* your problems.

Write today to: ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 717-D Alcoa Building, Mellon Square, Pittsburgh 19, Penna.

ALCOA CHEMICALS

ALUMINUM COMPANY OF AMERICA



Dehydrator at Sinclair Oil & Gas Company's Wertz Pressure Maintenance Plant, Bairoil, Wyoming. In this unit, one charge of ALCOA Activated Alumina remained in continuous operation from September 13, 1945, to March 1, 1954, dehydrating 8.3 billion cubic feet of gas.

For more data on advertised products, use Readers' Service Cards, last page.

What every reader of . . .

PETROLEUM REFINER should know!

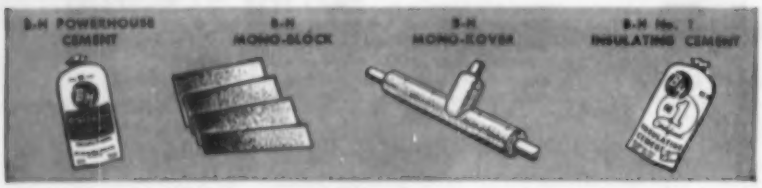
- Extra Light Density
- Easily Cut and Fitted
- Six Foot Lengths
- Resilient, Flexible
- Won't Break or Crumble
- Easy to Paint
- Highly Efficient
- No Coarse Fibers
- Takes Rough Handling
- Easily Nested
- Non-Corrosive
- Won't Rot, Decay, Mold
- Lower Applied Cost
- Factory Applied Vapor Barrier

Baldwin-Hill COMPANY

704 BREUNIG AVE., TRENTON, N. J.

Kalamazoo, Mich. • Huntington, Ind. • Temple, Tex.

Send for bulletin with data on how to apply, properties, selection help, sizes and thicknesses available



As Management Sees It . . .

America. He declared that Celanese had contracted with LaGloria Corporation in 1945 to supply 40 million cubic feet of gas daily to its Bishop plant. The price for this gas on a 15-year contract averages 5.25 cents per mcf, or $2100 per day. If this price is raised to 10 cents, it would cost Celanese $1900 a day on that one contract, he said. This would be $3.5 million extra during the remainder of the contract.

John D. Harper of Rockdale, speaking for the Aluminum Company of America, said Alcoa's Point Comfort Works buys gas at the wellhead in South Texas for an average of about 6 cents and delivers it through its own gathering system. If the state required the company to pay 10 cents for gas, it would add $1 million a year to Alcoa's fuel bill at the Point Comfort plant.

Harper declared that Alcoa came to Texas in 1949 because of abundant fuel, a good plant site, and a good climate. So many others followed suit that Texas is now the second largest aluminum producer in the U. S., led only by the state of Washington.

PETROLEUM REFINER was informed at month's end that a major petrochemical company with a plant in Texas is considering an East Coast location because fuel costs have doubled in five years. It was said that fuel has gone up only 20 percent in five years on the East Coast, which is also closer to market. If the move is made, the company will consider using a feed stock other than petroleum raw materials.)

Walling conceded that prices would be raised to some of the older purchasers who contracted for gas years ago. However, he said, "New industries are being established in Texas constantly and are making contracts for gas as fuel at the going price."

For . . .

The bill will remove inequities in gas pricing.

William J. Murray, Jr., chairman of the Railroad Commission, declared that "where a single purchaser of gas exists, there is always the possibility of inequity to the seller . . ."

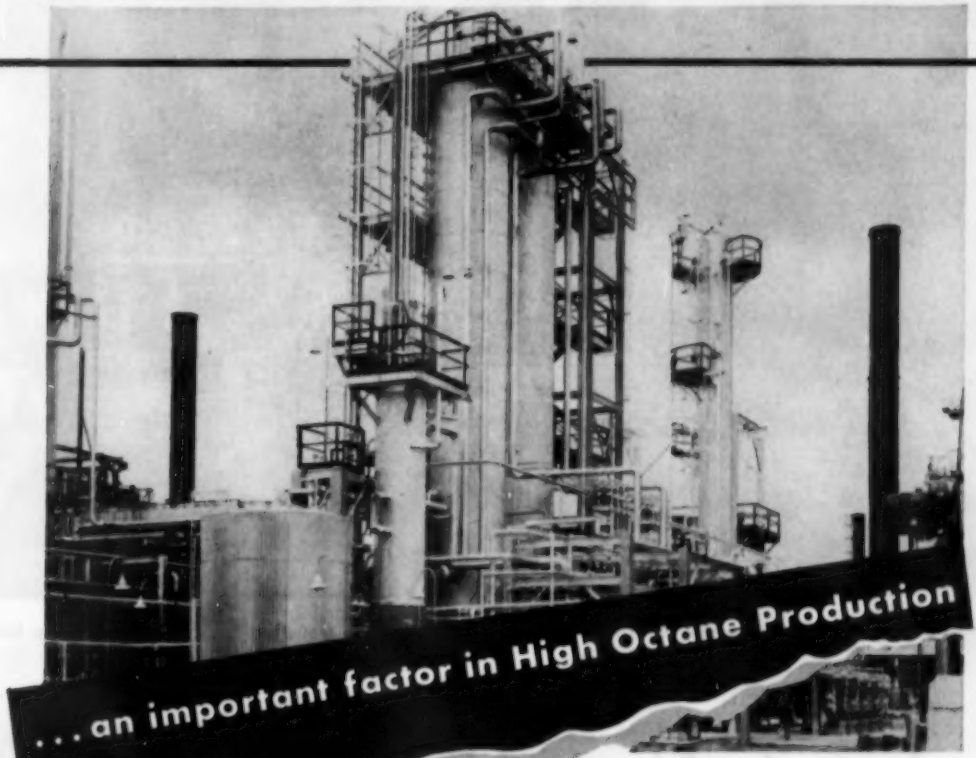
TIPRO's Woodward has charged that "A huge volume of gas is com-

See GAS PRICE BILL, Page 243

For more data on advertised products, use Readers' Service Cards, last page.

Addition to the 1954 Sky Line

NEW CAT-POLY UNIT for SOCONY-VACUUM



Recently turned over to the owners, Socony-Vacuum Oil Company, Inc., this modern phosphoric acid catalytic polymerization unit, under license from California Research Corporation, is currently producing high octane gasoline. Our engineering staff was responsible for complete design and erection.

This completion and the accompanying list of other current projects, will serve to emphasize the scope of our engineering service. It is as broad a service as the client wishes to utilize, including preliminary economic studies and competing process evaluations. It covers complete plants as well as processing units in the petroleum, petrochemical and chemical fields.

Should you assign us to work on *your* problem we would focus many years of engineering experience in the design of such processing plants and units plus the complementing experience of other important engineering services such as mechanical, electrical, structural, power and instrumentation.

Engineering

Design and Construction of Process Plants
•
Design and Construction of Process Units
•
Process Evaluations
•
Economic Studies

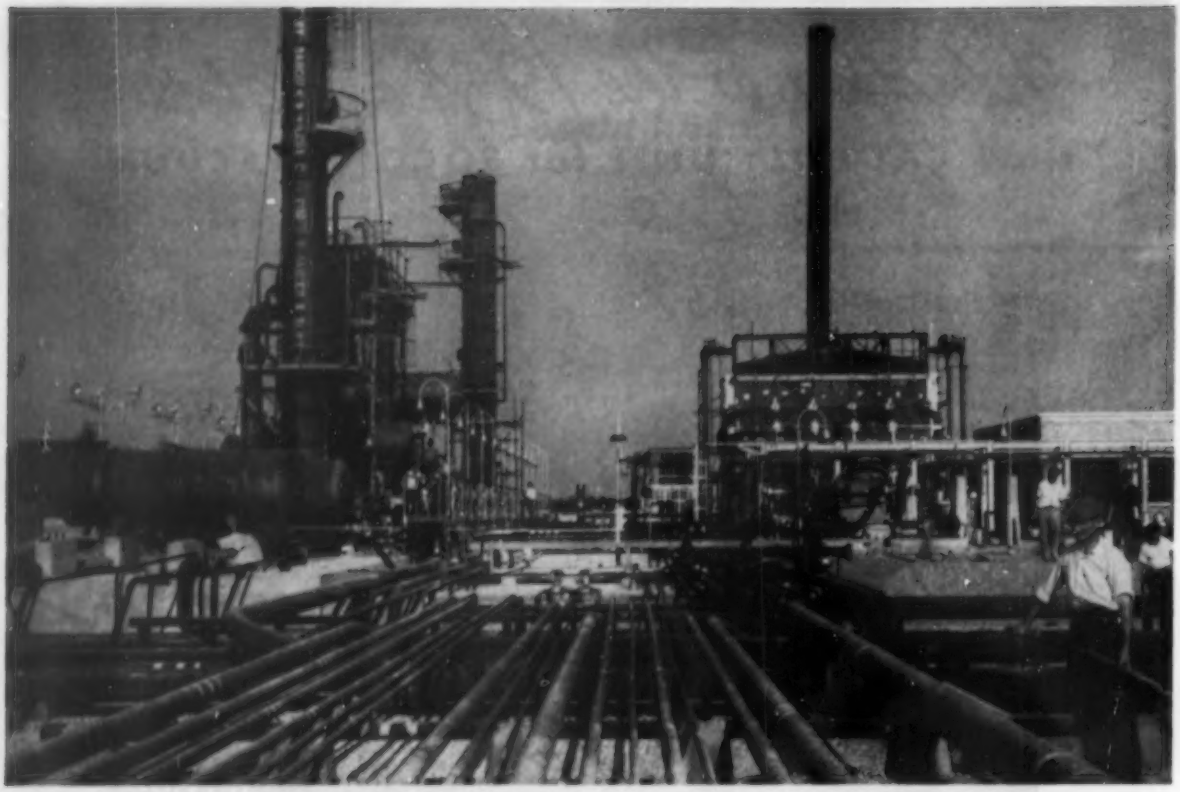
Other projects either recently completed or in advanced phases of design or construction include:

- **Aromatics Recovery from Petroleum Stocks**
- **Separation of Para Xylene**
- **Synthetic Methanol and Ethanol Refining**
- **Naphthalene Purification**
- **Recovery of Acetic Acid**
- **Gasoline Treating**
- **Refinery Modernization**

BADGER MANUFACTURING COMPANY

230 BENT STREET, CAMBRIDGE 41, MASS. 60 EAST 42nd STREET, NEW YORK 17, N.Y.

For more data on advertised products, use Readers' Service Cards, last page.



California-Texas Oil Company has a convertibility policy insuring its investment in the new refinery at San Martino di Trecate, Italy.

Investments Abroad Encouraged by U. S.

New liberalized insurance guarantees against loss in currency convertibility, expropriation, confiscation. Few companies responding to program.

Robert E. Spann
Petroleum REFINER Staff

NEW INVESTMENTS abroad by the American petroleum industry are being encouraged through more liberalized insurance guarantees backed by the U. S. government against inability to convert foreign currency earnings into dollars and against loss from expropriation or confiscation. It is part of the program administered by the Foreign Operations Administration to stimulate the flow of U. S. capital to foreign countries under the mutual security program.

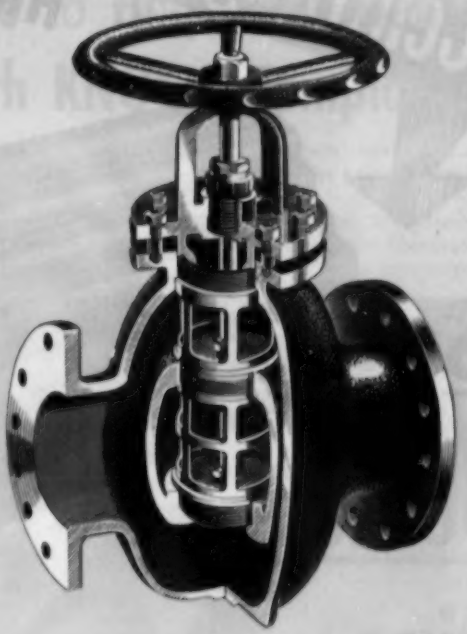
While such insurance dates back to the original Marshall Plan Act, it has been modified and simplified recently. The program offers insurance at a specified rate covering new investments, or new additions to existing investments, in the form of equity capital, loans, royalty and licensing arrangements and leasing of equipment. Cash investments must be in dollars or credits in dollars, or foreign currencies either purchased with dollars or freely transferable into dollars. Materials and equipment constituting new investments must be of dollar origin.

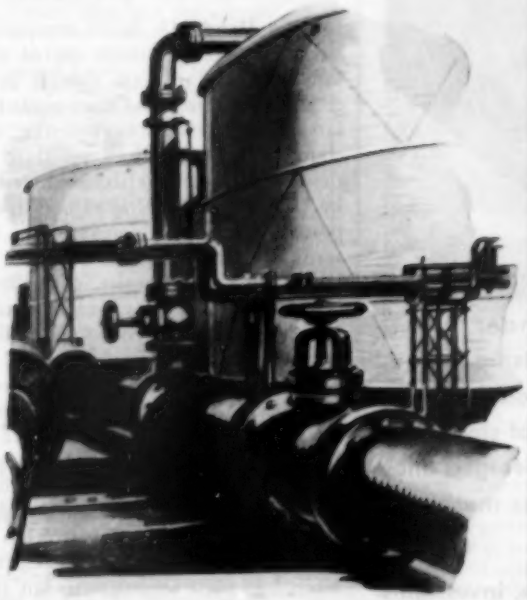
Normal Risks Excluded—The insurance is not protection against failure to make a profit in a foreign country or against other usual business risks that attend any investment. Specifically, the insurance does not protect against devaluation or depreciation of the basic exchange rate of a foreign currency, or against physical damage to property resulting from war, revolution or other causes. Expropriation or confiscation resulting from these causes are insurable, however.

The protection is designed solely as a practical insurance against two of

"Klingerise" -economise!

As a result of their outstanding characteristics "Klingerflow" Seatless Piston Valves are most economical in use. They operate on an entirely different principle from the usual type of seating valve. The valve consists basically of a finely ground piston, operated by the valve spindle and handwheel and moving through two or three non-metallic resilient valve rings, capable of resisting oil and most fluids at high temperatures and pressures, and separated by a ported lantern bush.





"Klingerflow" Valves are made in a great variety of designs and sizes, to suit all purposes, and have the following outstanding advantages :-

No seat — consequently no regrinding.

Can be serviced in the line.

Unaffected by wiredrawing.

Unaffected by throttled use.

INSTALL KLINGER SEATLESS PISTON VALVES

Write for the Klinger Master Catalog which describes the complete range of Klinger products.

RICHARD KLINGER LIMITED, KLINGERIT WORKS, SIDCUP, KENT, ENGLAND

Cables: Klingerit **Agents throughout the world** **Telephone: Foots Cray 3022**

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Telephone WILBANK 3181 Cable ROBCL
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THE KLINGER CORPORATION OF AMERICA
95, RIVER STREET, HOBOKEN, NEW JERSEY, U.S.A.
Telephone HOBOKEN 2-7915 Cable: KLINGDALE

Distributors and Agents in principal cities.

MANUFACTURERS OF KLINGER SEATLESS PISTON VALVES; KLINGER SLEEVE-PACKED COCKS; KLINGER LEVEL INDICATORS; RINGS AND SEALS IN KLINGER SYNTHETIC MATERIALS, AND KLINGERIT COMPRESSED ASBESTOS SHEET JOINTINGS AND PACKINGS FOR EVERY PURPOSE

DURASPUN

Centrifugally Cast Pipe

High Alloy

is Better Pipe

Centrifugal castings are superior castings. The metal is sounder, finer-grained, more uniform. It is free of gas pockets, blow holes and other defects often difficult to keep out of static castings. Tensile strength is close to that of rolled or hot-forged alloy steel. Dimensions are accurate, usually requiring less machining and finishing and thus speeding production.

If you require *extra* qualities in your high alloy pipe, investigate DURASPUN Centrifugally Cast Pipe. We can produce it in OD ranging from 2½" to 24" and in lengths up to 15' according to diameter. Our experience in the field of centrifugal high alloy castings dates back to 1931. Our experience in the field of static high alloy casting goes back to 1922. We can give you good service.

THE DURALOY COMPANY

OFFICE AND PLANT: Scottdale, Pa.
EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.
CHICAGO OFFICE: 332 South Michigan Avenue

As Management Sees It . . .

the chief dangers that trouble prospective American investors abroad—the risk of being unable to get their money out because of foreign exchange restrictions, and the risk of loss as a result of their investments being taken over by a foreign government.

Such insurance is now available for investments in 21 countries—Austria, Belgium, Formosa, Costa Rica, Denmark, France, Western Germany, Greece, Haiti, Israel, Italy, Japan, The Netherlands, Norway, Philippines, Portugal, Spain, Thailand, Turkey, United Kingdom, Yugoslavia and some 46 overseas dependencies of some of these nations—with which the U. S. has bilateral agreements permitting this insurance program to operate. In the United Kingdom and Turkey, the insurance protection is limited to currency convertibility.

Little Used—U. S. oil companies have made only limited use of this insurance so far even though as a group these companies have made the largest American investments, accounting for more than one-third of the approximately $11 billion invested by U. S. private capital abroad in the postwar years. The nature of the insurance makes its most attractive to investments in refineries, petrochemical plants, pipe lines and to equipment suppliers and process and patent holders servicing these facilities.

It is less attractive to investments in crude oil production facilities—which constitute the largest share of U. S. oil investments abroad—since such investments are small in comparison to the potential earnings, and therefore real value, of petroleum in the ground. The insurance is not prohibited to such investments, but it is limited to the actual amount of the investment.

Italian Refineries Aided—Insurance policies written on oil investments so far have covered four refinery projects, but the total face value of the coverage has been less than $30 million—an extremely small amount considering the U. S. investments of nearly $500 million in foreign refineries in the postwar period. The first of these policies in 1950 insured an investment made by Standard Oil Company (N. J.) for reconstruction of two jointly owned Italian refineries

For more data on advertised products, use Readers' Service Cards, last page.

DU PONT

PETROLEUM CHEMICALS DIVISION NEWS

DU PONT

April ★ One of a Series of Interest to the Petroleum Industry ★ 1955

THE "SIGN" OF A GOOD CUSTOMER

This booklet can help your dealers to recognize it . . . and profit from it

Credit customers, as you know, are generally *good* service station customers. They buy, for example, an average of *three gallons more* gasoline than cash customers and spend almost a *dollar more* per sale.

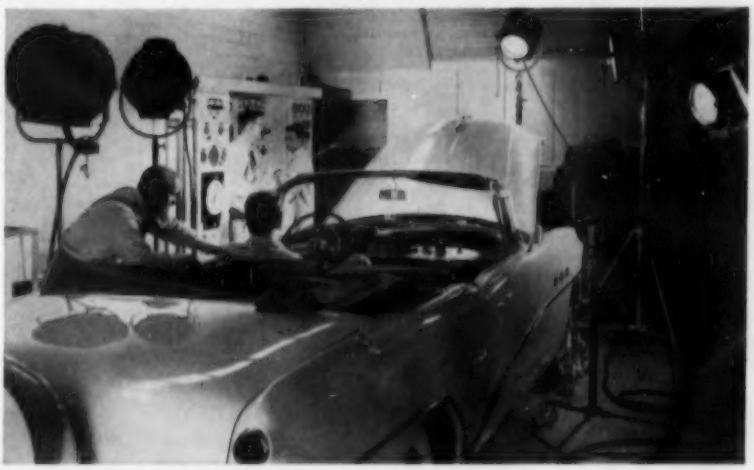
But many service station dealers and attendants fail to realize the value to them of these important customers. So to help your dealers get a better picture of the credit sales potential, we suggest that you distribute the above booklet to them. Entitled "A look at the credit customer," it is No. 3 in Du Pont's new "Looking through the windshield" series.

Any Du Pont Petroleum Chemicals Division representative or regional office will give you sample copies of these booklets . . . and cost information on ordering them in large quantities.

New Movie to Help Your Dealers Cope with KNOCK Complaints

"When the customer says 'KNOCK' " is the title of a new movie that offers your dealers a quick visual education on how to answer knock complaints in a salesmanlike way.

It is a 15-minute live-action sound movie in full color. Introduced by Tom McCahill, noted automotive writer and car authority, the film was produced by the Du Pont Petroleum Chemicals Division for oil company use.



DRAMATIC PROOF *of the mechanical, natural and human causes of knock are clearly demonstrated in the movie by the chassis dynamometer.*

The film explains dramatically the seven most common causes of knock—none of which are caused by gasoline quality. It gives dealers a clear, concise picture of how such things as temperature and altitude, poor mechanical adjustments, and bad driving habits cause knock. To help demonstrate these points the two-story chassis dynamometer at the Du Pont Petroleum Laboratory is shown in action in the film.

Familiar situations

To dramatize the causes of knock and make them readily understandable to dealers and customers, typical motorists driving several different popular makes of cars are shown encountering engine knocking problems under familiar, everyday

OVER

OCTANE NUMBERS— *Where are they going?...*

Here's how the Du Pont Quarterly Motor Gasoline Quality Survey can be of real value to you for long-range planning.

The average research octane numbers of all gasoline produced by the American petroleum industry have been steadily rising since the end of World War II. This average has risen from 84.3 in 1949 to 88.3 in 1954. The above figures are based on averages for both "regular" and "premium"—weighted on an area-grade-volume basis.

Of particular interest is the fact that the rate of increase during 1954 was nearly twice the rate of increase during 1952 and 1953.

And, based on the many new catalytic reforming facilities expected to come into operation during 1955, no slackening in this rapid rate of increase in octane numbers is expected to take place during this year.

The above information gives you an over-all picture of the national trend. But how do you relate it to your own individual situation? . . .

Right in your copies of the Quarterly Du Pont Motor Gasoline Quality Survey are all the details you need for applying the national trends to your own local marketing situation. With a number of previous issues in front of you, you will notice that almost every city or area tends to keep its own relative position in the over-all trend.

It is in analyzing and forecasting these long-range trends on a marketing area basis that your Du Pont Quarterly Survey can be most valuable to you. And each year, as new reports are added to the survey, it becomes more valuable as a planning aid.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

PETROLEUM CHEMICALS DIVISION
NEWS

CONTINUED

"Knock" Movie

driving conditions. This part of the movie also dramatizes the reactions of many customers whenever they hear an engine knock . . . a reaction which frequently, and erroneously, causes them to blame the gasoline rather than the true cause of the knock.

The problem of Ed Gilbert, a character in the film, is typical. Ed is shown driving his '54 Ford sedan down to the plains from a high mountain area where his home is and where much of his driving is done. As soon as he starts pushing his car across the low-level plains country, the engine begins to knock.

And what does Ed do about that knock?

He immediately decides the gasoline brand he's been using is no "blank-ity blank" good. And he, therefore, decides to switch his brand immediately.

Who's the real villain?

But will the switch really solve Ed's problem? Of course not. The villain causing the knock is the change in altitude. And the solution to this problem is a proper adjustment in the carburetor setting.

Other common causes of knock are graphically and dramatically explained in the movie. Examples of knock caused by changes in humidity and temperature . . . by mechanical factors such as an over-advanced spark, or a faulty water pump, thermostat or fan belt . . . and by poor driving habits are all included.

Good public relations

The more your dealers know about the common causes of knock, and the more of this knowledge they are able to pass along to their customers, the less you and your products are likely to be blamed for engine knocks.

The new Du Pont movie, "When the customer says 'Knock'," can help you tremendously in this important work. What's more, with its live-action drama and easy-to-understand dynamometer demonstrations, it is also suitable for showings to customer groups.

Available to you

A limited number of prints of this new movie are now available for your use. More are being made. Before you order yours, we suggest you contact our local representative for an advance showing.

ASSISTANT GULF COAST REGIONAL MANAGER

BARRY V. CORNWALL is now assistant manager for the Du Pont Petroleum Chemicals Division's Gulf Coast Region with headquarters in Houston, Texas. He was recently transferred to this post from the Division's Eastern Region, where he also served as assistant regional manager.

Since 1929, Mr. Cornwall has been continuously associated with the Du Pont Company. Following his first assignment as a technician in the service laboratory of the Dyestuffs Division, he became a salesman for the Alcohol Division's anti-freeze and industrial solvents. He later became assistant sales manager of the Alcohol and Camphor Section. He then joined the Petroleum Chemicals Division in 1952 as technical assistant to the director of sales.

Mr. Cornwall was born in Winnepeg, Canada, and graduated from Clemson College in South Carolina. During World War II, he served four years in the U. S. Army.

Write for this new book on Du Pont Lube Oil Additives

Polymeric lube oil additives combining effective low-duty detergency and V. I. improver qualities are a new and revolutionary development. And, until now, adequate information on their properties, application, and methods of addition has not been readily available.

A comprehensive discussion of these additives, however, is now available in a single book. This book, "Du Pont Lube Oil Additives 564 and 565" covers the basic aspects of this new development . . . including physical properties, low-temperature detergency and diesel detergency; effect on inspection data and bench test performance of oils; viscosity index improving characteristics; low-temperature wear properties and bearing corrosion characteristics. Details on toxicity and handling are also included.

The book is well illustrated with photographs of parts from test engines and detailed performance charts.

Copies are readily available from

any Du Pont Petroleum Chemicals Division representative or regional office listed below.

DU PONT
Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.)
Petroleum Chemicals Division • Wilmington 98, Delaware

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ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

A-9140

Printed in U. S. A.

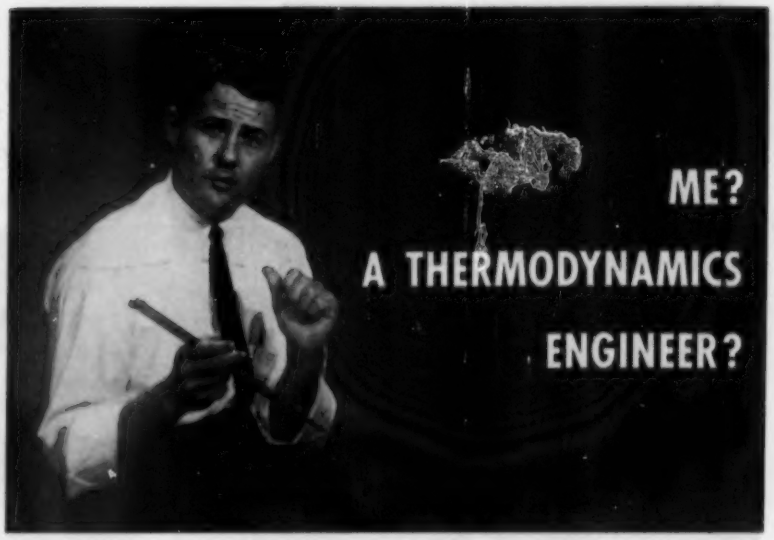
at Bari and Leghorn. This covered convertibility for a face amount of $14,487,500. A year later, California-Texas Oil Company purchased a convertibility insurance policy insuring its investment in a new 50 percent-owned refinery constructed at San Martino di Trecate, Italy, and a 97-mile pipe line from the coast.

The third refinery project is also in Italy, and was issued recently to Socony-Vacuum Oil Company to cover capital expenditure in its Naples refinery. This policy covers expropriation for a face amount of $2,800,000 and convertibility for a face amount of $5,600,000. Two additional insurance policies were written in 1952, both to Esso Research & Engineering Company, for a total of $1,084,000 insuring against inconvertibility for investments in engineering services to two French refineries.

Convertibility and expropriation are covered in separate policies. Each is written for a maximum of 20 years though the insured can terminate them on any anniversary date. Annual premium for each policy, executed for the government by the Export-Import Bank, is one-half or 1 percent per year of the face amount of the contract. Investments and insurance coverage on the investments must be approved by the foreign government as well as the FOA.

Convertibility insurance protects both transfers of earnings and repatriation of invested capital against the inability to convert such receipts into dollars. The insurance will not be sold unless convertibility of a foreign currency to dollars is available at the time the investment is made. While the policy does not protect against devaluation and depreciation of basic currency exchange rates, it does protect the investor against loss in the event of initiation of multiple exchange rates similar to those now in effect in some countries. These multiple rates frequently result in a less favorable rate of exchange for return on investments than for other foreign exchange transactions.

Repayment by FOA—In making payments under the convertibility insurance contracts, FOA uses basic reference rates for foreign currency and the investor is assured that receipts from foreign operations can be transferred into dollars at 95 percent of



Yes — Lockheed trains you at full pay

if you have an M. E. Degree and experience or training in
heat exchanger design
heat transfer
fluid flow
compressor or turbine machinery

The step up to Aeronautical Thermodynamics work isn't as steep as you might expect. Aircraft experience isn't necessary. Lockheed takes your knowledge of engineering principles, your experience in other engineering fields, your aptitude and trains you for aircraft work through a program adapted to the individual.

Part of the program includes on-the-job training. When necessary you attend Lockheed classes. Naturally, you receive full pay while training, as well as a wide range of extra employee benefits which add approximately 14% to your salary in the form of insurance, retirement pension, etc.

These opportunities for engineers in all fields have been created by the largest development program in Lockheed's history. Projects include: jet and turbo-prop transports; supersonic fighters far exceeding present aircraft in performance; advanced versions of vertical rising aircraft, jet trainers and bombers; nuclear applications to aircraft; and a large number of significant classified projects.

From a career standpoint, it is significant that much of Lockheed's development program involves commercial aircraft.

Equally important is the better life you lead in Southern California. Year-round sunshine, varied cultural and recreational opportunities, and scenic beauty of San Fernando valley provide the ideal background for modern living.

You are invited to write for a brochure describing life and work at Lockheed and a job application blank. Coupon is for your convenience.

Mr. E.W. Des Lauriers, Dept. T-19-3
Lockheed Aircraft Corporation
1708 Empire Avenue
Burbank, California

LOCKHEED
Aircraft Corporation
BURBANK, CALIFORNIA

Dear Sir: Please send me your brochure describing life and work at Lockheed in Southern California

My name _____

My present field of engineering _____

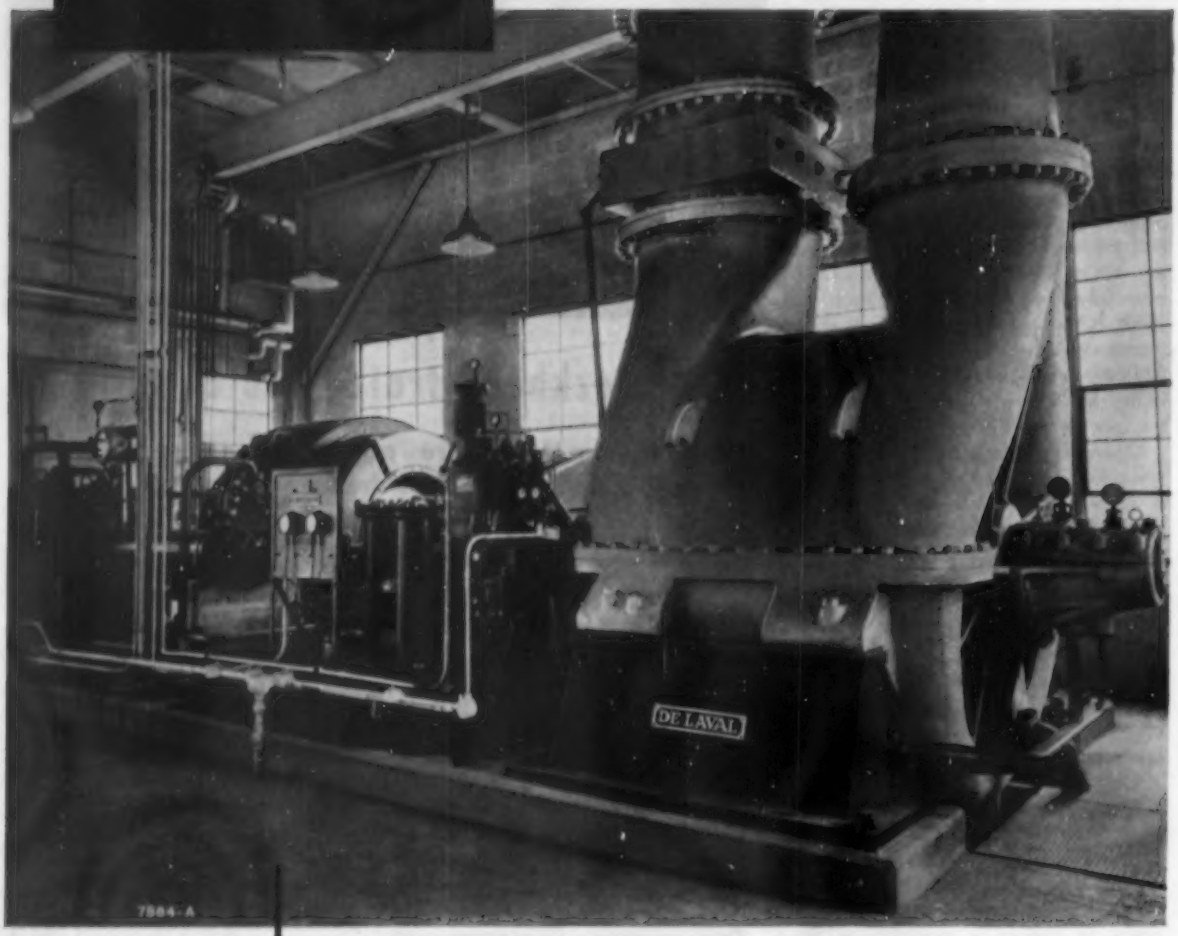
My street address _____

My city and state _____

For more data on advertised products, use Readers' Service Cards, last page.

DE LAVAL CENTRIFUGAL BLOWER

supplies 48,400 cfm for new British American cat cracker



Send for new Bulletin 0504

This De Laval centrifugal blower does a dependable job in the new Model B Orthoflow cat cracker of the British American Oil Co., Ltd. at Clarkson, Ontario.

The unit delivers 48,400 cubic feet of air per minute for the regeneration of spent catalyst. Inlet pressure is 14.2 psia, and discharge pressure 35.4 psia. The De Laval blower operating at 3,700 rpm is driven through a speed increasing gear by a 4,500 hp electric motor.

De Laval blowers are designed and built for heavy duty continuous operation. Rugged, horizontally split casings, individually designed impellers, perfectly balanced rotors and externally mounted, cylindrically seated bearings are design features that assure optimum performance and long service.

DE LAVAL *Centrifugal Blowers*

DE LAVAL STEAM TURBINE COMPANY

811 Nottingham Way, Trenton 2, New Jersey

DL307

the reference rate prevailing at the time. The 5 percent discount under the policy is an allowance for minor fluctuations and usual expenses of transfer commissions and the like that are normally borne by a foreign investor.

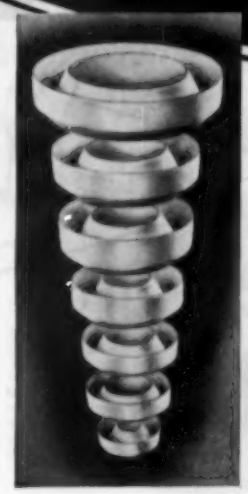
Convertibility contracts are written to provide a specific dollar coverage. For equity investments, ordinarily the maximum protection that can be bought is an amount equal to 200 percent of the dollar value of the investment. Under certain unusual conditions, greater protection is possible. The maximum loan investment coverage is the dollar amount of the principal, plus a reasonable rate of interest. The maximum protection obtainable for royalty and licensing agreements is the sum of the payments which can be reasonably expected over the life of the insurance contract.

The investor, in addition to having freedom of termination on any anniversary date, can reduce the face amount of the insurance and the face value is automatically reduced in relation to original capital repatriated from the investment.

Expropriation and confiscation insurance is written for a maximum dollar amount of protection which cannot be increased except by amendment covering additional new investment. Equity investments may be insured for the principal amount invested, plus a reasonable allowance for future earnings that could be expected to be reinvested in the enterprise. Loan investments can be insured for total principal amount plus all interest and in certain circumstances patents, processes and techniques can be insured against expropriation if dollar values can be reasonably determined.

In the event of expropriation, the U. S. government acquires by the insurance contract all the rights and claims of the investor relating to the insured investment and any compensation, other than dollars, paid by the expropriating government. The loss covered in equity investments through expropriation is the original amount of the investment (or the maximum covered by the insurance) with adjustments for reinvested earnings and depreciation. ##

"JOHN CRANE"
TEFLON*
"C-V" rings

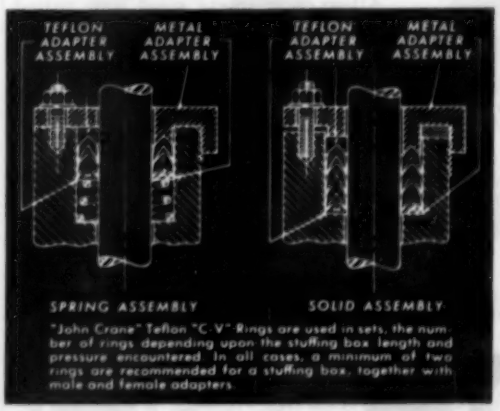


First preference
in refinery service
everywhere!
because...

Teflon "C-V" Rings withstand
1. Temperature from—94° F. to 482° F.
2. Any corrosive liquid or gas

Why repack with ordinary materials when chemically inert "John Crane" Teflon "C-V" Rings will effectively seal any corrosive liquid or gas and resist high temperatures as well. In addition, they have extremely low friction characteristics—will not shrink, swell, harden, dissolve, corrode or deteriorate. Ideal for use on all valve stems and reciprocating pumps as well as many centrifugal and rotary pump applications. Cross-section design allows sealing at finger-tight gland pressure.

"John Crane" has developed a complete line of standard size Teflon "C-V" Rings and male and female adapter rings to meet practically every need. If you have special requirements, "John Crane" can mold additional sizes to fit your stuffing box requirements.



"John Crane" Teflon "C-V" Rings are used in sets, the number of rings depending upon the stuffing box length and pressure encountered. In all cases, a minimum of two rings are recommended for a stuffing box, together with male and female adapters.

*DuPont's trademark

Request full information and ask for our bulletin, "The Best in Teflon." Crane Packing Co., 1820 Cuyler Ave., Chicago 13, Ill.

In Canada: Crane Packing Co., Ltd., 617 Parkdale Ave., N., Hamilton, Ont.

JOHN CRANE CRANE PACKING COMPANY 38 YEARS INDUSTRIAL PROGRESS

For more data on advertised products, use Readers' Service Cards, last page.

stainless steels are thoroughbred, too

The experienced exhibitor rents extra stalls... leaves them empty... to prevent contamination of his thoroughbred pets by canine neighbors.

To develop their best qualities demands *exclusive* care. That is why Sun Ship's new Alloy Products Shop has been planned for the *exclusive* fabrication of stainless and alloy steel products. When you have selected from the many available Alloys a stainless steel best suited for your service condition, you have done only half the job. You must also provide for the best possible fabrication if you are to have full protection—"A Thoroughbred Job."

Why entrust stainless steel to be fabricated in the same shop where carbon steel products are fabricated, and subject this precious metal to contamination with iron fragments, dust, or other harmful elements? A segregated shop is your answer.

Sun Ship now operates an all-alloy shop, one especially built and equipped for fabricating stainless and alloy products as they should be—segregated from carbon steel fabrication.

We emphasize the fabrication of medium and heavy stainless, alloy and aluminum products for industry.

Try Sun Ship for stainless fabrication as it should be done.

Our Sales Engineering Department will be pleased to assist you with any of your fabrication problems.

Sun Ship also makes all types of carbon steel pressure vessels.

ALLOY PRODUCTS SHOP

OF Sun SHIPBUILDING & DRY DOCK COMPANY

ON THE DELAWARE • CHESTER, PA. • 25 BROADWAY, NEW YORK CITY

Gas Price Bill

Continued from page 232

mitted for delivery to Northern and Eastern factories for boiler use. After being piped 1500 miles, this Texas gas sells more cheaply than it does at home. This is indeed an economic waste of a great natural resource. This bill will make it impossible for big pipe line companies to buy enough 3 and 4 cents gas to capture and subsidize Northern industrial markets."

Against . . .

The bill is wrong in principle. Price doesn't enter into true conservation.

Attorney Head argued that proponents of the bill are "parading under the guise of conservation. Their motives are selfish."

On the other side, Lieut. Gen. Ernest O. Thompson, senior member of the Railroad Commission, said physical waste sometimes exists because gas pressures are so low as to make it uneconomic to pull the gas out of the ground for sale at low prices.

For . . .

The bill will go far toward erecting an effective barrier against federal regulation and control of the entire gas industry.

TIPRO argues that the Federal Power Commission will respect the state's exercise of powers over gas pricing. If not, the case could presumably go to the Supreme Court, which has already affirmed the validity of minimum price laws in Kansas and Oklahoma. Thus, if the state chose to shut in a field because of low prices, the FPC would be forced to unfreeze prices to protect interstate consumers.

But Attorney Head charged last month: "This legislation is knowingly aimed at domestic industry and the homeowners of Texas. The sponsors know that it can't have any effect upon interestate commerce."

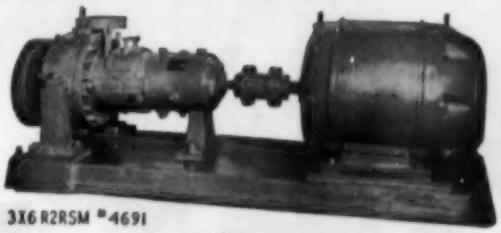
Against . . . . .

The bill will hurt industry's congressional fight to free gas from FPC control.

Many feel that there is no consistency between agitation against regulation at the national level and for regulation at the state level. It was feared that opponents of the Harris bill to amend the Natural Gas Act could make much of gas' two-way attitude.

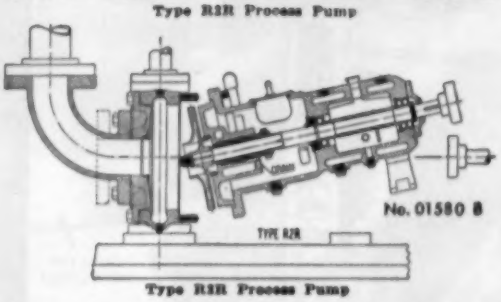
DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



3X6 R2RSM "4691

Type R3R Process Pump



Type R3R Process Pump

DISASSEMBLY: The Type R3R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

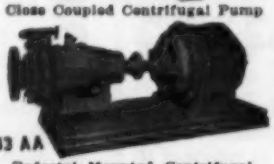
OPERATING RANGE: Type R3R, Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
Capacities: 50 to 2000 Gallons per minute.
Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

BUILDERS OF OUTSTANDING PUMPS SINCE 1869

CENTRIFUGAL and RECIPROCATING PUMPS

4044M
Close Coupled Centrifugal Pump

3510
Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids



4043 AA
Pedestal Mounted Centrifugal Pump

3033
Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump

4728
Double Pedestal Bearing Centrifugal Pump

3554
Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

ESTABLISHED 1869

DEAN BROTHERS PUMPS INC.

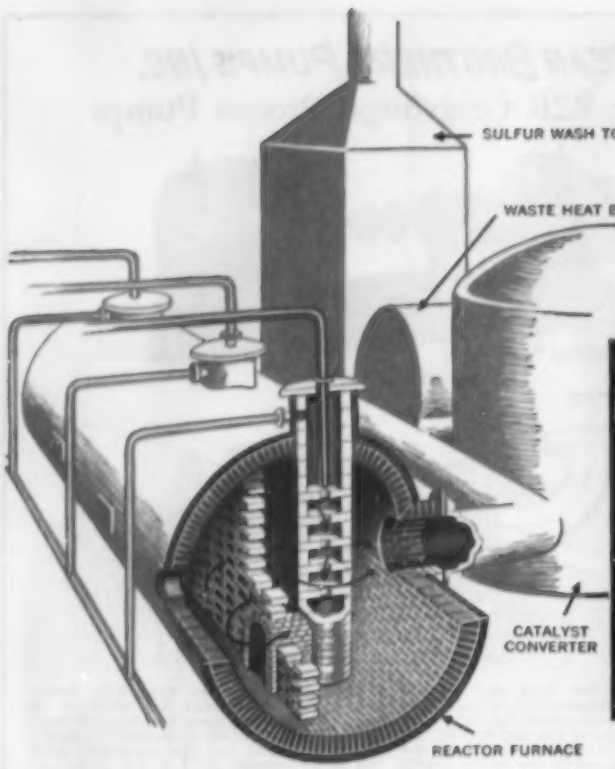
INDIANAPOLIS IND.

323 W TENTH ST.

Branch Offices: NEW YORK, N. Y., HOUSTON, TEXAS

Representatives in Principal Cities

For more data on advertised products, use Readers' Service Cards, last page.



The dependable Fluor Furnace is the key to a safer sulfur plant

The Fluor furnace is a cylindrical horizontal kiln built in one or more sections with manifold connections for parallel operation. Each section is complete in itself with its own special packing section to assure uniform oxidation. Combustion takes place on the surface of the hot firebrick, eliminating need for burners and preventing unburned H_2S from escaping.

The Fluor sulfur recovery process has a distinct advantage over other methods of producing elemental sulfur from waste hydrogen sulfide because of the design of the Fluor furnace. Outstanding in its simplicity and particularly in its safety factor, the Fluor furnace entirely runs itself. It is not affected by the composition of the gas, by the fluctuations in feed gas rate, or even by a complete interruption of feed gas. It is possible to shut down a Fluor furnace for as long as 60 hours and resume operation simply by readmitting the gas stream. Reaction starts immediately on the surface of the mass of hot brickwork, *leaving no possible chance for unburned H_2S to escape.*

The Fluor reactor furnace is the only one in sulfur plant use today based on recuperative heating. All others employ burners of one sort or another which must be relighted if flame is extinguished due to a fluctuation or interruption of feed gas or for any other reasons. To prevent escape of unburned H_2S, burner-type furnaces are equipped with flame detectors, automatic relighters and other emergency devices which are subject to failure. These are not necessary on a Fluor furnace.

Fluor-built sulfur plants operate at a 400° to 500° F temperature level at the catalyst beds with no danger of flooding the beds with sulfur. With burner-type kilns, should the flame fluctuate and catalyst reaction occur at too low a temperature, the catalyst beds are plugged with liquid sulfur, requiring shutdown. Catalyst in the Fluor process need only be changed every 3 to 5 years.

The Fluor furnace can handle much leaner gases than other processes. If economically feasible, the Fluor process can recover sulfur from an H_2S gas stream with a sulfur concentration as low as 15% (dry basis). An internal brickwork recuperative-heat exchanger incorporated into the furnace makes this possible. The temperature of the feed gas is preheated sufficiently before it reaches the reaction zone for more thorough combustion. This feature is exclusive with the Fluor design.

The first sulfur plant on this continent utilizing this process was built by Fluor for the Southern Acid and Sulfur Company in 1942. It is still in operation, producing a high grade (99.97%) sulfur. Since then Fluor has built a significant number of sulfur conversion units with equal success.

BE SURE WITH **FLUOR**

THE FLUOR CORPORATION, LTD
LOS ANGELES 22, CALIFORNIA
FLUOR OF CANADA · TORONTO
READ BRIGHTON · LONDON

ENGINEERS
CONSTRUCTORS
MANUFACTURERS

NEW YORK
CHICAGO
PHILADELPHIA
BOSTON
PITTSBURGH
SAN FRANCISCO
HOUSTON
BIRMINGHAM
TULSA
DENVER

Why Employes Quit—

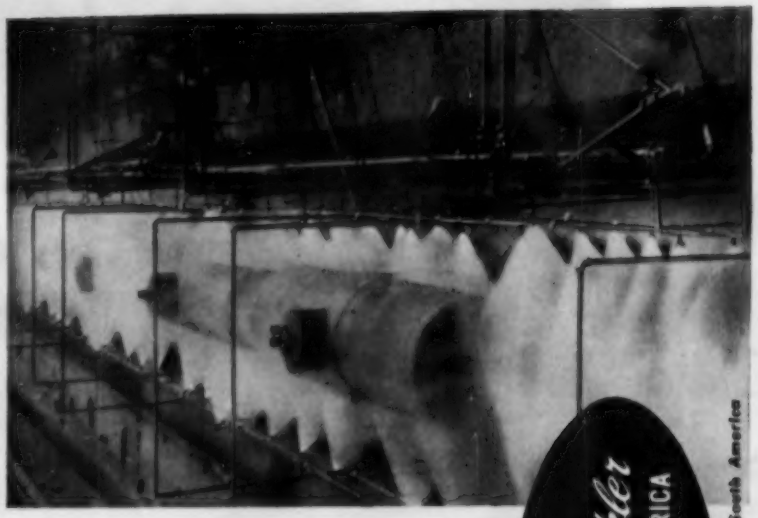
Continued from Page 106

tardy, absentee type." Gradually the distant-living employe notices this apparent untrusting attitude in the supervisor, and he develops a reciprocal lack of confidence in the management. Eventually, he ends up in the exit interview complaining about transportation, the ability of the supervisor, and lack of confidence in management.

Three other climates or patterns appear. A general *human relations pattern* emphasizes concern with broken promises by supervision, friction with co-workers, company interest in employee welfare, freedom of communication, promotion, ability of supervisor, confidence in management, and job effect on personal happiness. A *security pattern* emphasizes complaints about job security, working conditions, confidence in management, ability of supervisor, interest in employe welfare, broken promises by supervisor, job effect on personal happiness, and friction with co-workers.

An *upgrade pattern* is evident in the illustration in a tendency toward simultaneous complaint about promotion, pay, and freedom of communication. Poor housing complaint is also included, relating oppositely with pay complaint but consistently with grievances about promotion and freedom of communication. The "rush to get ahead" pattern is apparent here. Promotion and access to "higher ups" are considered important—along with pay and satisfying family housing. They do not feel that the present employment permits them to meet their pay and prestige goals fast enough.

General Interpretation—Some personnel policies which appear to save money in the short run may actually lose even more money in the long run because of the high costs of labor turnover. The over-all research suggests the high value to stockholders of managements and supervisors who are filled with warm understanding of human needs—administrators and leaders who are themselves willing to undergo considerable frustration in their relations with subordinates, to turn the other cheek, to work hard at earning and retaining confidence and long service of all personnel. ##



MAINTAINING PROFITS WITH ENGINEERED "Automatic" FIRE-FOG PROTECTION

Tank car loading and unloading operations are a major hazard to many chemical and petroleum processing plants. Even a localized fire could mean severe loss to business continuity, equipment and profits.

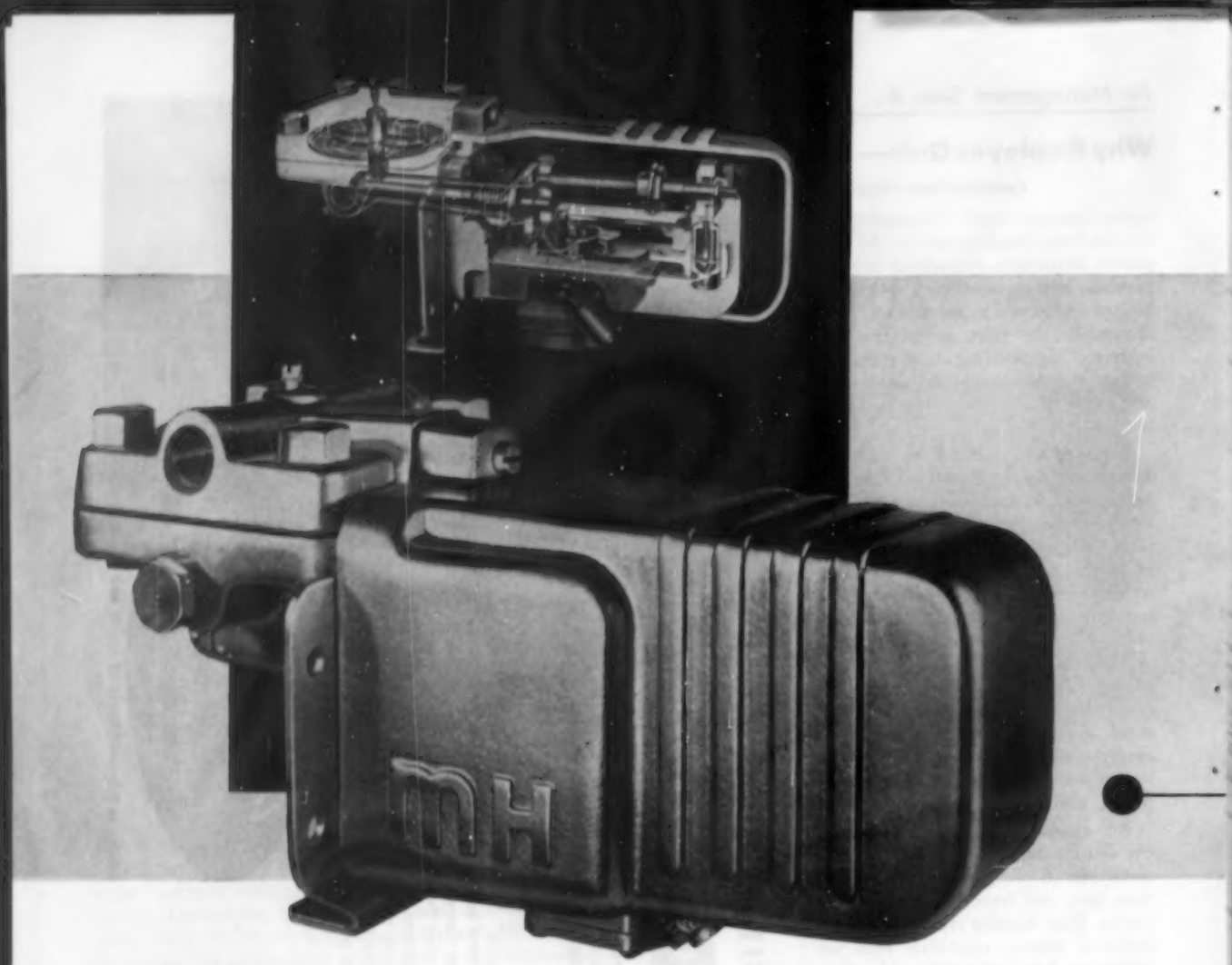
That's why "Automatic" Sprinkler engineers were called upon to design, manufacture and install fire protection as shown in operation at this large West Coast petro-chemical plant. ENGINEERED "Automatic" FIRE-FOG was the answer to this problem. Yours may call for fixed piping systems of "Automatic" Sprinklers, AIR FOAM, CO_2, or some other tried and proved method of fire control and extinguishment. The conditions involved dictate the procedure to follow in providing the proper type of protection "best by test" for any fire hazard.

"Automatic" Sprinkler staff of technically trained engineers as well as Laboratory and Test Yard facilities are available to you without cost. We'd welcome the opportunity to counsel with you as a friend—not just a supplier. There's a common objective in mind . . . safeguarding lives, property and profits from the constant menace of fire.

"Automatic" Sprinkler CORPORATION OF AMERICA YOUNGSTOWN, OHIO.

Offices in Principal Cities of North and South America

For more data on advertised products, use Readers' Service Cards, last page.



Every feature your application requires!

CONTINUOUSLY ADJUSTABLE RANGE
Easy field adjustment of range from 0-20 to 0-200 inches of water.

SIMPLE DESIGN
Uses no mercury . . . has few moving parts . . . practically no maintenance.

SIMPLE FIELD CALIBRATION
Check with weights in minutes . . . no curves or tables. 1 lb.=10″ water.

LOW AIR CONSUMPTION
Model with pilot relay uses only 0.05 cfm of air.

HIGH SPEED
Practically instantaneous response to changes in flow or level.

HIGH TEMPERATURES
Withstands fluid temperatures up to 350°F . . . ambient temperatures to 225°F.

RESISTS CORROSION
Teflon diaphragm and stainless steel meter body eliminate usual need for seals or purges.

EASY INSTALLATION
Compact, lightweight unit is easily mounted anywhere.

● ***Plus these new features for liquid level measurements:***

LOWER RANGES
Extended down to 0-14 inches of water for liquid level applications.

VERSATILE CALIBRATION
Direct-reading scale, with up to 100% suppression of calibrated range.

Pace-setting performance for flow measurements— *now for liquid level, too!*

the Honeywell **Differential Converter**

THE remote transmitter that has set new standards of performance in flow applications—the Honeywell Differential Converter—is now available in a new model for liquid level measurements in closed vessels. Suitable for use with either pressure or vacuum vessels, this model offers all the features of fast response, precision, convenience and ruggedness that have earned the Differential Converter wide acceptance throughout industry. The line now covers practically *any* flow or liquid level measurement.

This versatile pneumatic transmitter uses no mercury. It can be used in scores of installations where contamination problems have long impeded measurement. Operating on the force-balance principle, it provides exceptional precision and high-speed response . . . makes possible closer control in the most critical applications.

The ideal companion for Honeywell *Tel-O-Set* miniature indicators, recorders and controllers, the Differential Converter can transmit to any of a variety of Honeywell instruments.

Whenever you have a flow or liquid level measuring problem, you'll find the Differential Converter offers you the top in performance and serviceability. Your nearby Honeywell sales engineer will be glad to discuss your requirements in detail. Call him today . . . he's as near as your phone.

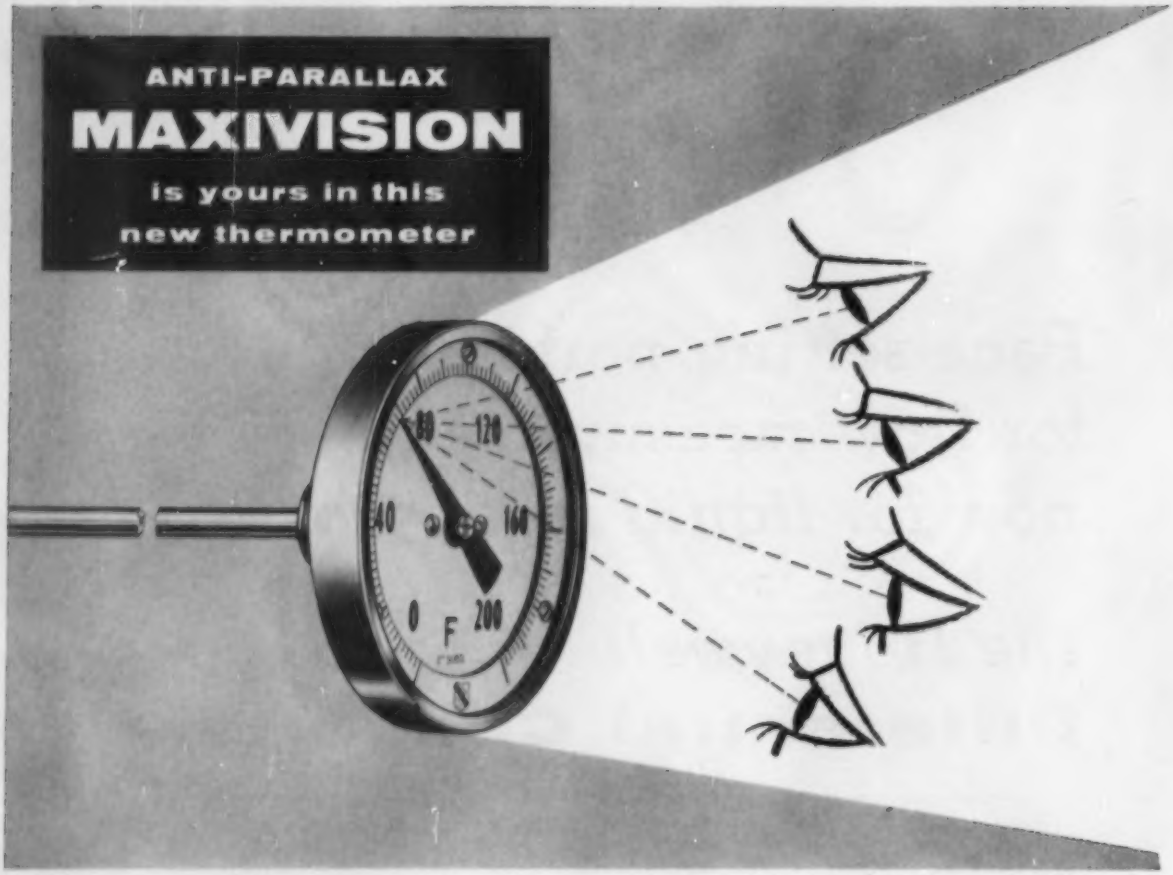
MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Penna.

● **REFERENCE DATA:** Write for Bulletin 2291, "Differential Converter Liquid Level Transmitter", and for Bulletin 1160, "Measuring and Controlling Liquid Level."

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls



Now you can read temperatures *right at the process* with the same ease, accuracy and economy as pressure readings. The Anti-Parallax Maxivision Dial on this new all stainless steel American Bi-Metal Thermometer assures these important advantages. The large, easy-to-read black figures and graduations are carried on a raised ring set close to the glass, with pointer at the same level. Parallax error is practically eliminated.

With this new thermometer in service, field operators can eliminate frequent trips to the control house to observe process changes. Indoors or outdoors, this fine, all stainless steel American instrument is truly climate-proof. Because the case is only 3" in diameter, the thermometer fits where space is limited. Ample clearance behind the case makes installation easy and fast with a small wrench. Read the specification highlights, then get full details about this new high-accuracy American Bi-Metal Thermometer.

PHONE your Industrial Supply Distributor for prompt attention to your needs. He is always ready to help keep your production going by making fast delivery from local stocks.

SPECIFICATIONS

New AMERICAN ALL-STAINLESS STEEL BI-METAL THERMOMETER with ANTI-PARALLAX MAXIVISION DIAL

Dial: Exclusive anti-parallax Maxivision dial, with scale approximately 6" long. Pointer set at same level as scale.

Climate-Proof Case: All stainless steel. 3" diameter. Threaded bezel. Selected clear, extra-heavy cover glass. Heat-resistant gaskets between glass and case seal the thermometer against rain, frost, sand, dust, fumes—climate-proof.

Temperature Ranges: From minus 80° to plus 1000° F. Accuracy within 1% of range.

Low-Mass Bi-Metal Coil: Welded to stem plug. Accurately centered in stem. Non-freezing, non-corrosive silicone fluid on coil dampens vibration, accelerates heat transfer, speeds response; does not gum, resists capillary action.

Pointer: Index type. Easily accessible from front of dial for positive adjustment over entire range. Pointer shaft guided by friction-free bearings.

Stem: 18-8 stainless steel, mirror polished. All joints welded. Resists corrosion. Provides strong, rigid and tight closure against process pressures. Lengths: 2½" to 24".

Connection: Fixed, ½" N. P. T.

Separable Sockets: Available for use in closed systems or where measured medium is corrosive to the stainless steel stem. Fit over all standard stem lengths except 2½".

AMERICAN INDUSTRIAL INSTRUMENTS

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'ASHCROFT' GAUGES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, *Stratford, Conn.* HANCOCK VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

What's Happening . . .

. . . in the Industry

Sunray, Mid-Continent Boards Approve Merger

Stockholders of Sunray Oil and Mid-Continent Petroleum corporation will meet next month, to vote on a plan for merging the two companies. The plan, worked out by the directors of the two companies, has been approved in principal by the two boards.

Directors of the merged company, to be known as Sunray Mid-Continent Oil Company, will include nine present members of the Sunray board, with six directors from Mid-Continental.

C. H. Wright, Sunray chairman, would be chairman of the new company, with W. C. Whaley, president of Sunray, serving as president. Robert W. McDowell, now president of Mid-Continent, would be president of D-X Sunray Oil Company, a subsidiary which will handle pipelining, refining and marketing, as well as vice chairman for the parent company.

Sunray men named to the board, besides Wright and Whaley, would be J. K. Ellis, D. L. Frawley, Edward Howell, F. B. Parriott, A. A. Seeligson, Glenn J. Smith and Paul E. Taliaferro. Mid-Continent members, in addition to McDowell, would be J. Luther Cleveland, Jacob France, William F. Morton, E. M. Rouzer and Jay R. Walker.

New Union Sets Sights For 1,000,000 Members

The U. S.'s newest union seeks also to become one of the country's most powerful. O. A. Knight, president of the recently-formed CIO Oil, Chemical and Atomic Workers International, has announced that the union hopes to build its membership to one million.

The new amalgam of the Oil Workers International Union and the United Gas, Coke and Chemical Workers Union means to seek its goal by further merger and organizing areas where membership is thin. It now represents some 200,000 employes for bargaining purposes.

With plans for further expansion, came word that the union would consider itself free to ask for additional wage increases during 1955. The statement was made by the Bargaining Policy committee as a wave of 4 percent increases were being granted throughout the industry.

According to the committee, unions were receiving a wage increase in 1955 which was due oil workers in 1954. For this reason, there is a possibility that the union may launch a campaign during the next few months for what it calls "1955 wage increases."

NPC Sets May Meeting

National Petroleum Council will meet May 5 in Washington, D. C. Reports will be heard from committees on Petroleum Imports, Oil and Gas Defense Organization, Petroleum Production Capacity and Tank Truck Transportation.

Houdry Has Two New Processes, One for 100-Octane Gasoline

Houdry Process Corporation has announced the development of a reforming process by which high yields of 100-octane clear automobile gasoline may be obtained from low-octane naphthas.

A second new refining technique announced by Houdry this month is a catalytic cracking process found to convert the bottom of the petroleum barrel into valuable refinery products without leaving heavy residue.

The catalytic cracking process, in commercial operation for a year at Sun Oil Company's new Sarnia, Ont., refinery, is credited with greater yields of high-octane gasoline and domestic fuel oil, total conversion of heavy residue and elimination of the production of heavy residual fuel oil.

In the case of the new reforming process, pilot-plant runs in three schematic variations produced approximately 86, 87 and 91 percent conversion of naphtha feed stock to 100-octane clear gasoline. The company reported that the addition of tetraethyl lead would further increase the octane number.

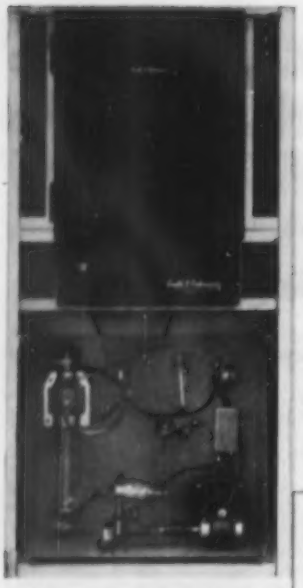
With slight operational modification one of the three variations would yield more than 82 percent conversion to 108-octane (F-1 clear) gasoline for blending with refinery pool gasolines of lower anti-knock

TABLE 1—Summary of Iso-Plus Process with Supplemental Process Variations

	Naphtha Charge (Barrels Per Day)	100-Octane Clear Gasoline	Conversion (Percent of Charge)
Houdriforming, depropanizing, depentanizing, separation of aromatics, Houdriforming of raffinate, depropanizing, butane blending	6,600	5,993	90.8%
Houdriforming, depropanizing, debutanizing, depentanizing, recycling raffinate to Houdriformer, aromatics to blending	6,600	5,781	87.1%
Houdriforming, depropanizing, depentanizing, thermal reforming, debutanizing, catalytic polymerization, blending	6,600	5,671	85.9%

Sets California Safety Record—

National Safety Council officials take note of a 4-million man-hour safety record made at Tide Water Associated Oil Company's refinery in San Francisco. The record, for a period dating from Nov. 1, 1953, surpasses the previous accident-free mark of 3,973,204 man hours for California refineries. Left to right are Tom A. Burke, assistant director of the council's Western region, watches Arnold E. Archibald, president of the San Francisco chapter, point to a plant announcement poster held by Oscar Larson, refinery manager, and Samuel O. Bacon, plant safety engineer.

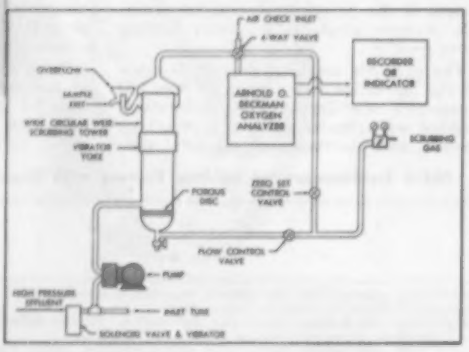


NEW
Arnold O. Beckman
DISSOLVED OXYGEN ANALYZER
for continuous measurement!

- **handles fluids, sludges, etc.**
- **simple operation**
- **accurate and continuous measurement**

Photo shows analyzer in top section, scrubbing unit below.

Diagram illustrates how O_2 is stripped from sample with scrubbing gas, then resulting gases analyzed for O_2.



Accurate measurement of dissolved oxygen is recognized as an important control factor in operations such as sewage and water treatment, waste disposal, chemical processes, and many others.

Now you can accurately, simply, and continuously make such measurement—with the new Model 1A3B Dissolved Oxygen Analyzer!

The new Model 1A3B combines the field-proved Arnold O. Beckman paramagnetic Oxygen Analyzer with an improved method of stripping to provide a measurement specific for oxygen.

The Model 1A3B can be directly connected to any standard potentiometer-type recorder or indicator. No special accessory equipment is needed. Readings may be in percent saturation or ppm.

The Model 1A3B is adaptable to handling samples with high solids content . . . under abnormal temperatures or pressures . . . or those having other difficult sampling conditions.

Using the Model 1A3B is far superior in speed, accuracy, and convenience to conventional chemical methods. Information needed for optimum processing is provided immediately.

Ranges: *From a maximum of 0-100% O_2 saturation to a minimum of 0-5 ppm full scale. Intermediate ranges also available.*

Accuracy: *3% of full scale.*

Get the full story on the Model 1A3B. Write directly for information. Ask for Data File # 17W-48.

Arnold O. Beckman INC.
Instruments for Science and Industry
1020 MISSION STREET
SOUTH PASADENA, CALIFORNIA

What's Happening. . .

rating, resulting in higher over-all pool octane number.

The new process is named Iso-Plus because the anti-knock rating of its product equals the 100-octane rating of iso-octane (2, 2, 4-trimethylpentane) used in determining gasoline octane numbers, and because it involves Houdry catalytic reforming plus other processing.

Single-stage Houdriforming units are capable of converting high proportions of naphtha charge to 100-octane gasoline. The point was made, however, that this is possible only when operating the Houdriforming reactors at severe intensity with naphthas of low paraffin content as feed stock.

Because of these limitations, methods of using Houdriforming in combination with additional processing were investigated. The new Iso-Plus process, with several optional processing combinations, is the result.

One Iso-Plus route permits the combining of Houdriforming and aromatics extraction in either of two arrangements, and the other variation utilizes Houdriforming in combination with thermal reforming.

Experimental Iso-Plus processing of a naphtha containing 46 percent paraffins and having an end boiling point of 394 F. indicated yields of 10-pound Reid vapor pressure 100-octane F-1 clear gasoline as shown in Table 1.

In the first and third Iso-Plus process variations, small amounts of outside butanes are required to supplement process-produced butanes blended to the reformate.

New Catalytic Process

Houdry's new catalytic cracking process draws its name—Houdresid—from its ability to convert metal-contaminated residue into high-quality products. Residue, having little value except in asphalt or bunker oil, has been a troublesome problem to the refining industry.

Commercial operation of the Houdresid process at Sun's refinery in Canada is reported to mitigate the effect of heavy metal contaminants on the catalyst. Heavy metal deposited on the catalyst in the Sun cracker has had no significant effect on catalyst activity or selectivity.

Mechanical design of the Houdresid unit is based on equipment developed in the Houdriflow moving-bed catalytic process for cracking gas oil fractions of crude petroleum. Slightly higher equipment and operating costs for Houdresid processing are expected to be made up by higher values in products.

Sun Oil has conducted Houdresid catalytic cracking since May, 1954, in which reduced crude representing 50 percent bottoms from a mixture of Texas, Louisiana and Mid-Continent crudes were charged to the unit.

Approximately 64 percent gasoline was produced from the residuum, as compared to 52.5 percent motor gasoline yield from vacuum distillation plus catalytic cracking.

API Movie Receives Foundation Medal

For "helping to bring about a better understanding of the American way of life," the American Petroleum Institute's latest motion picture, "The Story of Colonel Drake," has been awarded the

For more data on advertised products, use Readers' Service Cards, last page.

KING SIZE

This giant 37 ton Cat Poly Reactor is one of 4 units shipped to a large petroleum refinery in the State of Washington. It is 4'-3½" in diameter by 32'-0" long and has a 1 3/16" thick shell. Each of its 8" thick heads is attached to the shell channel with 28 special alloy stud bolts 2¾" diameter by 15¼" long having nuts 4¼" across the flats. Into the 5¾" thick tube sheets 190 tubes, 2½" O. D., No. 5 gauge and 30'-0" long, are rolled and seal welded. Designed for 1,230 lbs. pressure on the tube side, the reactor was completely X-rayed and stress relieved.

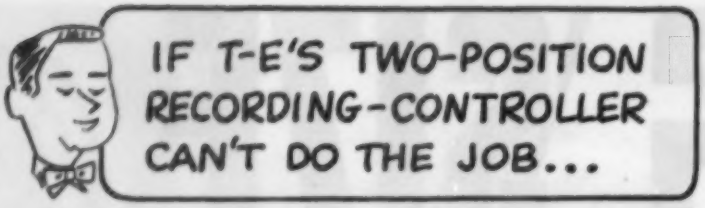
Vogt, a leading builder of shell and tube reactors for poly plants, has the competently skilled personnel and modern mechanical facilities with which to provide heat transfer equipment for the most exacting services in petroleum refineries, chemical plants, and related industries.

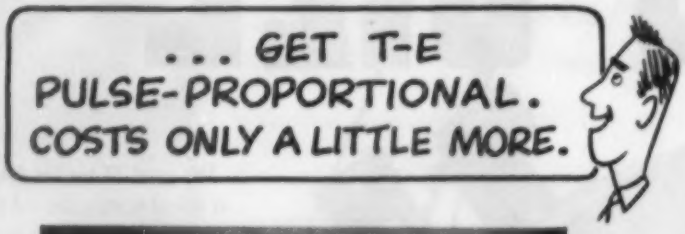
Reactors ...by Vogt

A bulletin describing the wide range of heat transfer equipment built by Vogt is available upon request.

HENRY VOGT MACHINE CO., LOUISVILLE, KENTUCKY

BRANCH OFFICES: NEW YORK, CHICAGO, CLEVELAND, DALLAS, PHILADELPHIA, ST. LOUIS, CHARLESTON, W. VA.





Thermo Electronic recording-controllers are relatively inexpensive instruments for recording and controlling temperature of electrically heated, fuel fired, or steam heated equipment. You can use them with two-position valves (electric or electric-pilot pneumatic types), contactors, or heavy duty relays. They will operate with thermocouples or resistance bulbs.

The pulse-proportional controller changes heat input according to the magnitude of temperature change. Its proportion band is continuously adjustable from 0% to 20% of range to match process response. Recommended for continuous and other processes having similar control characteristics, where load changes are relatively small, and where temperature changes cannot be detected quickly.

Two types of controller: potentiometer pyrometer and resistance thermometer. Both are durable, simple, accurate, sensitive, speedy, and easy-to-set. 23 scale ranges from −320° to +200°F all the way up to 0° to 3000°F. The 12" recording chart is easy-to-read.

Interested? Write for bulletin 62– X.

Pyrometers • Thermocouples • Protection Tubes • Quick-Coupling Connectors
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What's Happening. . .

George Washington Honor Medal by the Freedoms Foundation.

This is the fourth time a public information film produced by the Institute and its Oil Industry Information committee has been cited by the foundation. Previous API films honored by the foundation were "Crossroads, U. S. A.," "Man on the Land" and "24 Hours of Progress."

In each case, the object of the motion picture was to tell the story of oil, its development as an industry and its contributions to social progress under the system of free enterprise.

"The Story of Colonel Drake" was released last October. Starring Vincent Price, the picture recreates the moments near Titusville, Pa., when in 1859 the world's first commercial oil well was brought in.

Prints of the motion picture may be purchased or borrowed through any district office of the Oil Industry Information committee.

Magnolia to Shut Down Fort Worth Refinery

Magnolia Petroleum Company will close its 13,320-barrel-a-day Fort Worth, Texas, refinery May 1. The plant has been losing money for several years.

Special blendings and premium gasolines have been shipped from the company's Beaumont, Texas, refinery for several months, to upgrade gasoline to meet present quality requirements.

Listed as a reason for closing the 40-year-old refinery was the cost of expanding facilities to manufacture high-grade products. Another reason for the shutdown is that Fort Worth is no longer as favorably located for product distribution.

Magnolia's plant is the second Fort Worth refinery closed within a year. Gulf Oil Corporation closed its 9435-barrel-a-day plant there last summer. The only other refinery left in operation in the area will be a 7500-barrel-a-day plant run by Premier Oil & Refining Company.

The Magnolia refinery, put on steam in 1914, has a daily capacity for 8325 barrels of cracking, 1998 barrels of reforming and 5883 of coking. It could produce 1887 barrels of cat-poly gasoline a day and 127 tons of coke.

Plans for disposing of the equipment were not complete, but some may go to the Beaumont refinery, which has a daily crude capacity of 200,000 barrels. The site will be used for a small-scale terminal operation.

Bureau of Standards Investigates Asphalts

In a study of the effects of weather on asphalt, L. R. Kleinschmidt, a member of the Bureau of Standard's Building Technology laboratory, has developed a method of separating asphalt into four groups of components, according to their physical characteristics.

Kleinschmidt dissolves asphalt in n-pentane and separates the soluble and insoluble materials which result. After removing the insolubles, which are asphaltenes, the resulting solution is absorbed on fuller's earth in a chromatographic fractionating column. The saturated fuller's earth then

6 TANKS CLEANED IN 5 HOURS

Chemical cleaning by DOWELL prepared 216,000-gallon oil tanks for conversion to sulfuric acid storage

A steel company wanted to convert six 216,000-gallon tanks from fuel oil and gasoline storage to sulfuric acid storage. It was necessary to remove oil and tar film from the inside walls and ceilings of these tanks.

Dowell engineers, using special high-pressure hoses and nozzles, sprayed thickened chemical solvents over all internal surfaces from the tank floor. No scaffolding was required. The thickened solvents clung to the tank walls during the cleaning process. The entire surfaces of all six tanks—including seams, rivets and braces—were cleaned in only five hours.

Whatever *your* cleaning problem—pipe lines, boilers, process equipment, water wells—take it to Dowell. Their engineers have the experience, materials and equipment to help you cut cleaning costs—keep up production. Get in touch with the nearest of over 130 offices or write direct to DOWELL INCORPORATED, Tulsa 1, Oklahoma, Dept. D-31.

Dowell engineers prepare solvents based on the type of deposit to be removed. They furnish all necessary pumping and control equipment. And they apply the chemicals according to the technique demanded by the job: filling, spraying, jetting, cascading or vaporizing. Dismantling is held to a minimum.

chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

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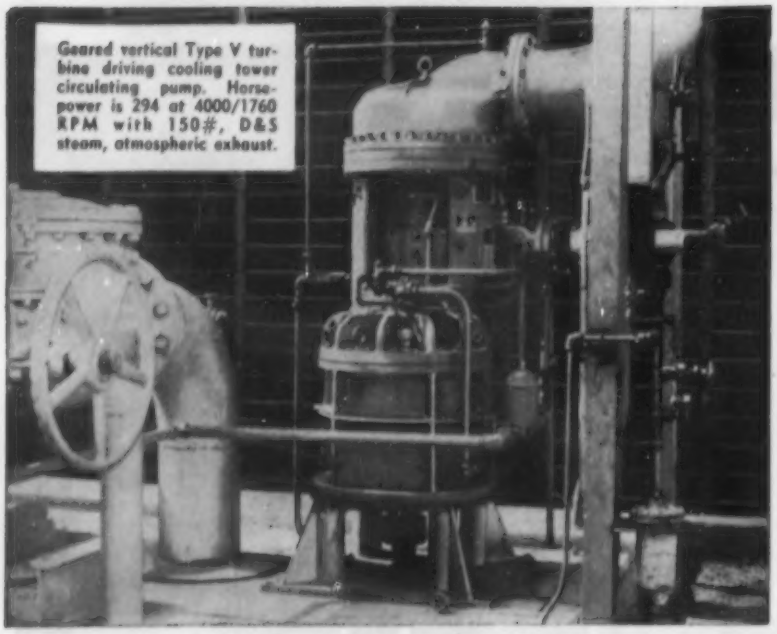
Murray Turbines



Geared vertical Type V turbine driving cooling tower circulating pump. Horsepower is 294 at 4000/1760 RPM with 150#, D&S steam, atmospheric exhaust.

● Murray Vertical V turbines, both geared and direct-connected, are being used more and more for driving vertical pumps of all types. The Murray Vertical V turbine is designed from top to bottom as a vertical turbine, not just a horizontal turbine, "upended." The Murray Vertical is especially constructed and arranged for vertical mounting.

Murray vertical turbines can be furnished for steam pressures up to 600#, 750° F. TT. and back pressures as high as 100# and can carry most normal thrust loads imposed by vertical pumps.

MURRAY IRON WORKS COMPANY

BURLINGTON, IOWA

Builders of Steam Power Equipment for Three Quarters of a Century

What's Happening. . .

is washed with solutions to separate individual components.

The object of the Bureau's study of the degradation of roofing asphalts, sponsored in part by Asphalt Roofing Industry Bureau, is to determine why some asphalts resist weathering better than others, how to distinguish the highly resistant from those which weather poorly, and how to improve the weather resistance of poor asphalts.

Sale of Rubber Plants Gets Senate Approval

The Senate has voted to approve the government's plan to sell 24 synthetic rubber plants to private industry. Sales are expected to bring the government $285,465,000.

A resolution was approved ordering the Rubber Producing Facilities Disposal Commission to continue negotiations another 60 days to sell the plant at Baytown, Texas. Sale of the 44,000-ton GR-S plant fell through when the commission and the government's operator, General Tire & Rubber Company, failed to agree on a price.

Warren Petroleum Forms New Operating Division

Warren Petroleum Corporation has formed a new Terminal & Transportation division, under Rex V. Phelps. The division will coordinate all the company's storage, terminating and transportation operations for finished products.

Phelps, who will continue as head of the Engineering and Construction department, also has jurisdiction over four other departments combined into the new division. The departments will remain under their previous managers:

H. A. Montgomery, Natural Gasoline Storage; John T. McKenna, LP-Gas Storage; H. A. Busten, Traffic, and C. R. Heaney, Marine department.

Brazell New WPRA Prexy

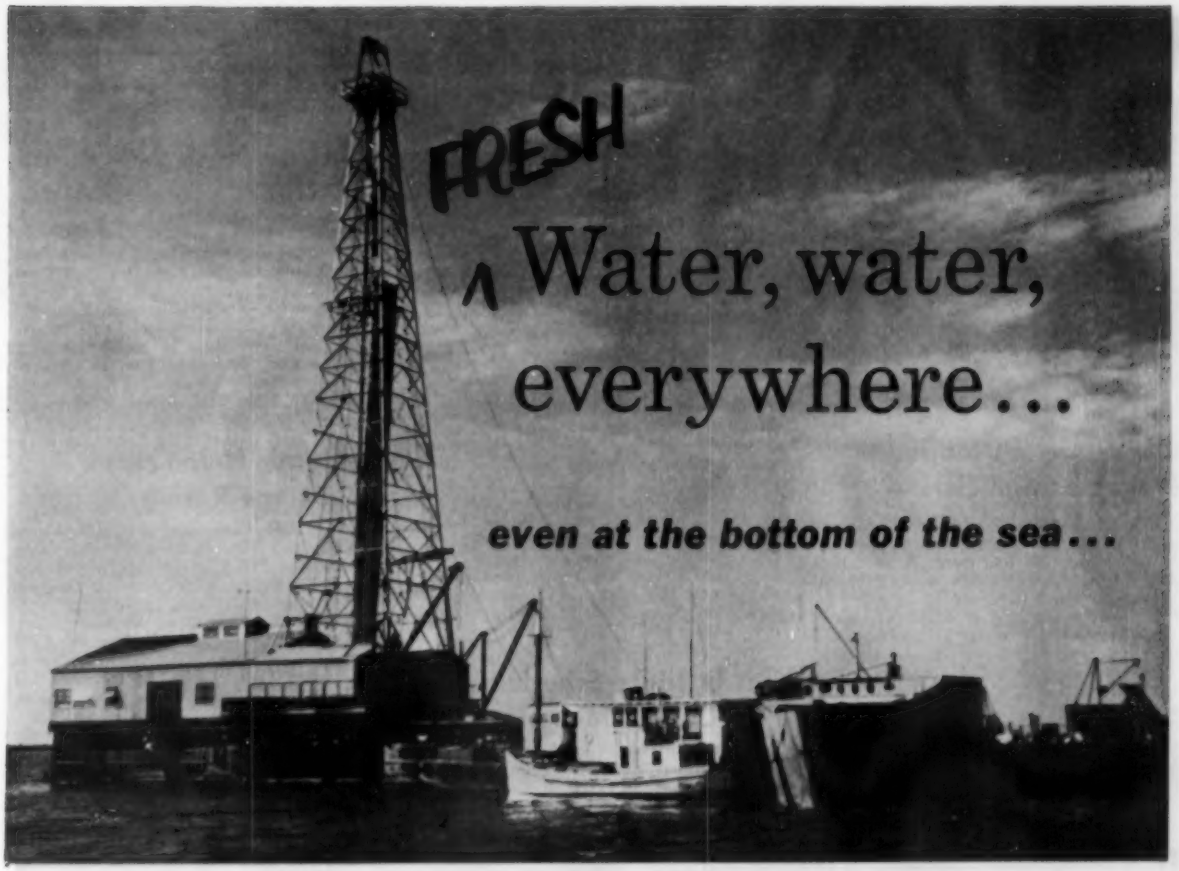
Reid Brazell, of Leonard Refineries, Inc., Alma, Mich., is the new president of Western Petroleum Refiners Association. He succeeds Roland V. Rodman of Anderson-Prichard Oil Corporation. Other officers: J. W. Vaiden, Skelly Oil Company, Tulsa; F. L. Martin, Suntide Refining Co., Corpus Christi, and H. J. Kennedy, Continental Oil Co., Houston, re-elected vice-presidents; and Bruce K. Brown, Pan-Am Southern Corp., New Orleans, elected a vice-president for this first time. The annual meeting was held in San Antonio the last week in March.

Paul D. Walliams was appointed Secretary-Treasurer.

Sinclair to Continue Experiments at Rifle

Sinclair Research Laboratories, Inc., which has developed a method of recovering shale oil by controlled underground combustion, plans to continue its experiments on the Colorado project.

During its exploratory phase of the shale program, the company demonstrated that oil could be produced by controlled underground combustion. It is hoping to



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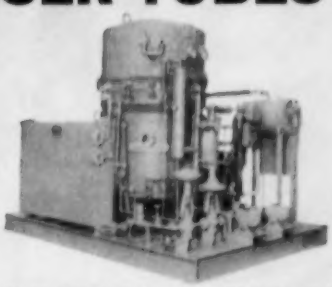
Distilling fresh water from the sea is one of many services Bridgeport Condenser Tubes perform dependably and economically.

The reason is simple, and important. Bridgeport Tube Alloys are carefully selected to meet the conditions in each application... assuring you the most effective performance possible over the longest time. The *right* alloy handles each job, whether in marine or stationary power plants, chemical or process plants, refineries or off-shore drilling rigs.

You get the biggest return possible, in terms of service, from your condenser tube dollars.

Bridgeport Technical Service will be glad to analyze your application and recommend the Bridgeport Condenser or Duplex Tube best suited to your operating conditions.



Pure, fresh water for drilling mud make-up, engine cooling, and drinking is distilled from the sea on this rig by a Cleaver-Brooks Sea Water Evaporator equipped with Bridgeport Arsenical Admiralty Condenser Tubes.

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What's Happening. . .

eliminate mining and the handling of large quantities of rock to produce shale oil commercially.

The new Sinclair process retorts shale oil in place and the oil is pumped to the surface as in conventional crude production. Future field tests will require new equipment. A research crew has conducted initial experiments near Rifle for the last two summers.

U. S. Geological Survey estimates that that recoverable reserves of shale oil in the U. S. are almost seven times as great as the present proved reserves of crude oil. Sinclair's Colorado oil shale deposits represent commercial reserves equivalent to 700 million barrels.

Oil Workers Dropped From Essential List

The production of oil, natural gas and oil products has been dropped from the government's list of essential activities. The list serves as a guide to draft boards in acting upon deferments.

An earlier list had included oil categories. The recent revision, however, reduces the Department of Commerce's classification of essential activities, along with a Department of Labor list of critical occupations.

Exemptions have been granted in industries listed by the Department of Commerce only to personnel holding positions classified by the Department of Labor as critical occupations.

Standard Development Changes Name to Esso

Standard Oil Development Company has changed its name to Esso Research and Engineering Company. An affiliate of the Standard Oil Company (New Jersey), the firm is responsible for Standard research and engineering in this country and abroad.

The company spends more than $40 million yearly in research and engineering on petroleum and petroleum-derived products and refinery processes.

Standardization Proposed For Chemical Industry Pumps

A proposal by the chemical industry for standardizing centrifugal pumps, a project estimated to save $6,800,000 a year to the chemical industry alone, is being circulated by the American Standards Association.

The proposal, made to the association by the Chemical Industry Advisory Board, deals with low pressure centrifugal pumps used by the chemical industry. Pumps were classified as horizontal, end-suction, single-stage and electric. The approximate maximum range is five to 1000 gpm, with temperature to 500 degrees F.

Gas Institute Schedules First Classes for June

Institute of Gas Technology will open its fourth annual summer session in natural gas technology June 13 in Chicago. The institute, affiliated with Illinois Institute of Technology, will offer four separate three-week courses in the fundamentals of the major areas of operations.

"Natural Gas Production and Processing," will be presented June 13-July 2; "Natural Gas Transmission," July 5-July 22; "Natural Gas Distribution," July 25-Aug. 12, and "Natural Gas Fuel Utilization," Aug. 15-Sept. 2.

Instruction will be at the college senior level and is designed to familiarize engineers with current problems and practices in the gas industry, current research and up-to-date methods of measurement and computation. Individuals may enroll in single courses or in several courses.

Applications for enrollment will be accepted up to 30 days before the opening day of each course. Requests for application forms should be directed to the institute at 17 West 34th Street, Technology Center, Chicago 16.

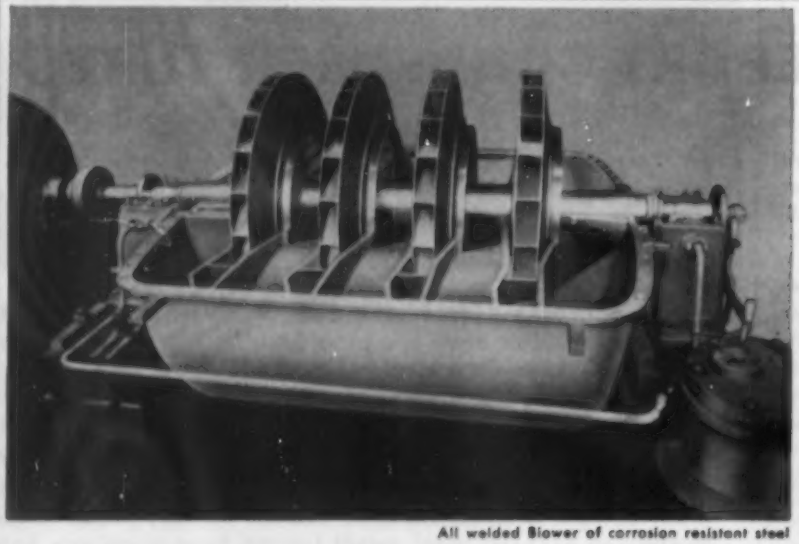
California Union Hits 97 Octane Rating

Union Oil Company of California is moving into top position in the West Coast octane race by introducing a new premium gasoline with a rating close to 97.

And in the Mississippi Valley market, Sunray Oil Corporation is furnishing 97 octane premium gasoline for delivery at Memphis, Tenn., on specifications of Oklahoma Mississippi River Pipe Lines, Inc.

Average ratings of premium fuels on the West Coast are about 94, with top octane ratings hitting around 95.

With the advance in octane rating came an advance in Union's selling price. The



All welded Blower of corrosion resistant steel

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A TRULY efficient safety relief valve for pressure storage tanks must remain tightly closed at all pressures within the working range, yet must open without fail whenever internal tank pressure tends to exceed the working limit. The Shand & Jurs Pilot Operated Safety Valves meet these specifications to a "T." They provide the important insurance against property damage and personnel hazards caused by failures due to excessive internal tank pressures.

The S&J Pilot Operated Safety Valve, Fig. ST-5000, incorporates a special seal on the main valve pallet preventing any leakage prior to full opening. It operates exactly at the set pressure with a minimum of blowdown, requiring no accumulation of pressure above this setting for full opening. A special "peeling action" on valve seating surfaces minimizes interference by freezing or sticky foreign substances. Should the diaphragms be damaged or ruptured, the valve will continue to operate at a lower pressure. Available in 4" and 6" sizes for pressure ranges of 1 to 10 pounds.

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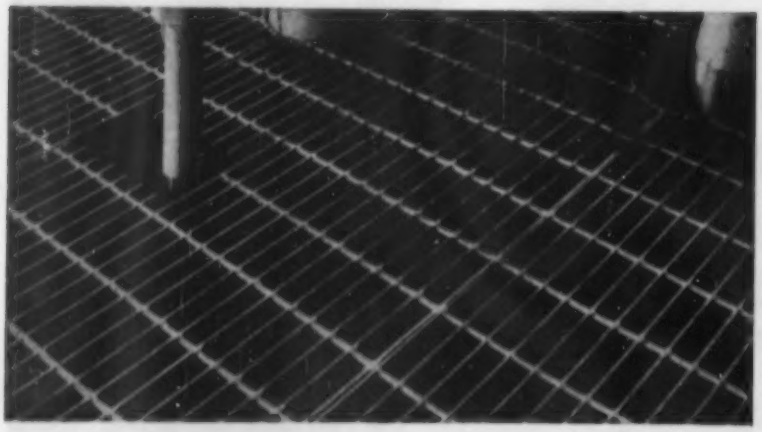

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What's Happening. . .

company increased its prices a cent above other premium gasolines, and then upped the price a cent on regular gasoline which had been rated on a par with some company's premium.

Government to Delay Closing Plant at Rifle

The government has ordered a delay in closing its experimental shale-oil plant at Rifle, Colo., until current research is completed. Department of Interior spokesmen have announced they intend to close the plant, however, despite attempts by congressmen from the Rocky Mountain states to block the attempt.

Union Oil Company of California plans to build a pilot plant at Rifle, with a daily capacity of 1000 tons of shale, as compared to 150 tons handled at the government plant. The company plans to build a commercial plant if its experiments are successful.

Atomic Power Seen As Competitor to Oil

Congressman Carl T. Durham has predicted that atomic power plants will be developed within the next five years to produce power as cheaply as coal, oil or water. The North Carolina Democrat, vice chairman of the Senate-House atomic energy committee, said that a reactor would be built during the next two years capable of producing power as cheaply as any heat element now in use.

Pennzoil Board Approves Merger with South Penn

A plan for merging Pennzoil Company into South Penn Oil Company has been approved by the directors of both companies. The plan will be presented to Pennzoil stockholders June 15, and South Penn shareholders will vote on the proposal the following day.

South Penn owns a majority of the stock in Pennzoil Company, operator of a 10,000-barrel-a-day refinery near Oil City, Pa.

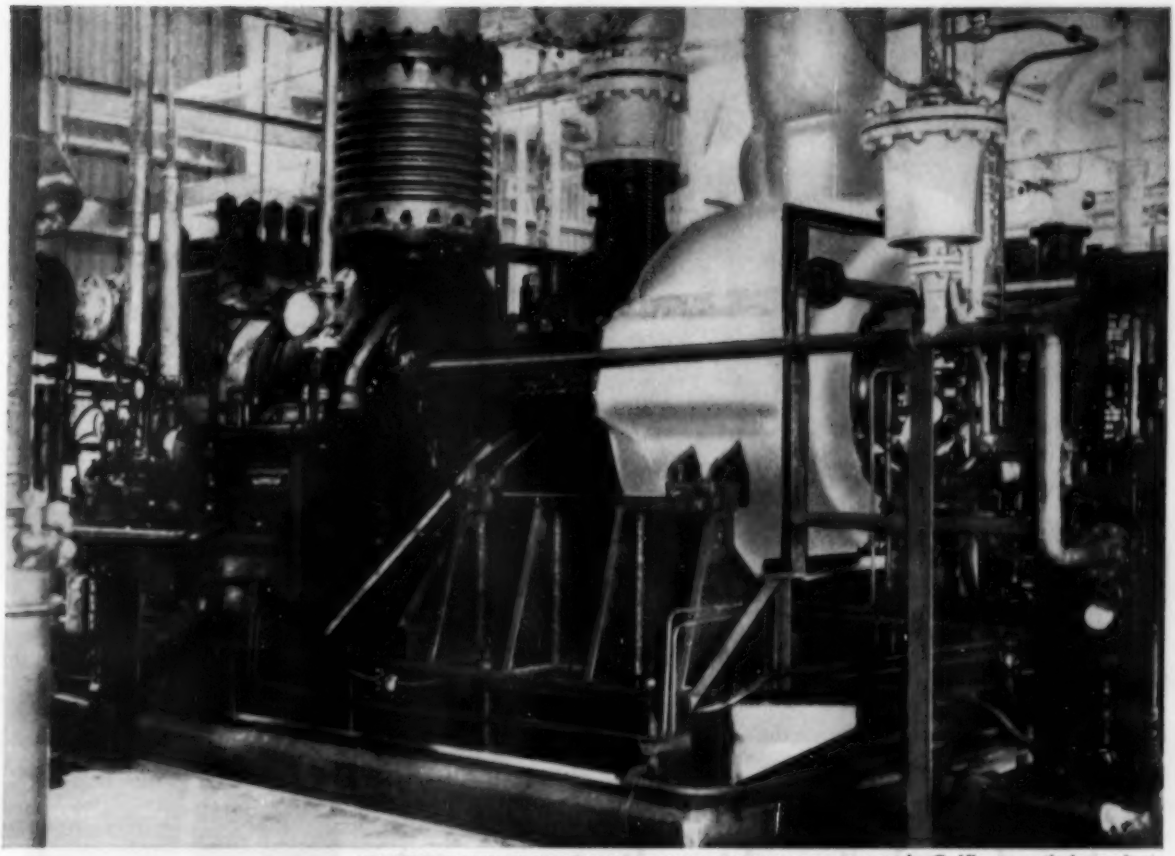
Under the merger, Pennzoil would operate as a division of the surviving company. Brand names of its products, Pennzoil motor oil and Pennzip gasoline would remain unchanged.

The agreement provides for Charles L. Suhr, Pennzoil chairman, to be the chairman of South Penn Oil Company. He would replace George J. Hanks, who will be named as president.

R. W. Grunert would be senior vice president of South Penn division, with W. S. Zehrung serving in a similar position for Pennzoil division. All present directors of the two companies would be members of the board for the surviving company.

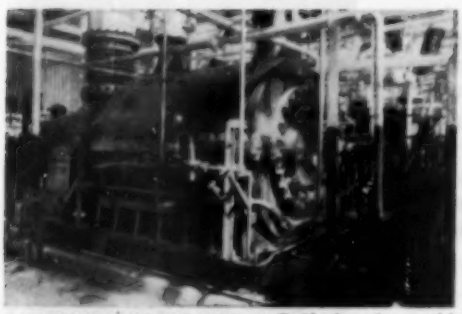
Atlantic Sells Subsidiaries

The Atlantic Refining Company has sold its subsidiary companies in the Eastern Hemisphere to Anglo-Iranian Oil Company. One of the subsidiaries involved was the Atlantic Refining Company of Africa Ltd. This company has extensive business interests in South Africa.



WORTHINGTON CENTRIFUGAL REFRIGERATION COMPRESSOR in Gulf's new ethylene plant. Nozzles are for interstage bleed which boost discharge flow to four times initial suction flow.

New Gulf ethylene plant offers "curb service"



HANDLING CHARGE GAS at Gulf plant keeps this Worthington centrifugal compressor busy. Water injection nozzles control temperature, prevent co-polymerization.

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What's Happening . . .

. . . *Among Men* in the Industry

John O. Larson has been elected secretary of Standard Oil Company (New Jersey) to succeed Adrian C. Minton, who retired after 36 years with the Jersey organizaation.

Former assistant secretary to the company's executive committee, Larson has been a member of the Jersey organization since 1909. He joined the company as a junior file clerk while completing his education in evening classes at New York University. He became assistant manager of the Coordination department in 1944, and was advanced to the assistant secretary's post in 1950.

G. S. John and **H. M. Brennan** have been appointed as leaders of research groups at the Standard Oil Company (Indiana) laboratories at Whiting, Ind. Both were assigned to the Hydrocarbon Research division.

A third research scientist receiving an appointment as group leader at the Whiting laboratories is J. E. Wolf, assigned to the Process division. Dr. John will work on fundamental catalysis and radiotracers, while Dr. Brennan will be assigned to catalyst preparation and catalytic cracking.

Holder of a doctor's degree from Ohio State University, where he also was employed, Dr. John began with Standard as a chemist in 1950. During the war, he worked with the Manhattan Project. Dr. Brennan joined Standard as a chemist in 1952, after receiving his doctor's degree at Washington University.

Wolf, with an advanced degree from Carnegie Institute of Technology, joined Standard in 1943 as a chemical engineer. Previously, he had been employed with Wolverine Tube Company.

H. B. Snider has been named to head the Utilities department at The Humble Oil & Refining Company's refinery in Baytown, Texas.

Snider

Joining Humble in 1920, Snider served 18 years as foreman at the boilerhouse, 10 as general foreman for power and water and five as general foreman for utilities, power and water in the Mechanical Utilities department.

T. Q. Elliott has been named process supervisor at Stanolind Oil & Gas Company's synthesis and chemical plants at Brownsville, Texas. Formerly senior process engineer in the company's Research department, Elliott has been with Stanolind since 1946.

T. B. Kimball, manager of refineries for Sinclair Refining Company, has been elevated to vice president. Others receiving promotions to vice presidential positions are C. R. Campbell, assistant general sales manager; A. J. Geary, manager of export sales, and W. M. Flowers, president of Sinclair Research Laboratories, Inc.

Ciapetta

Frank G. Ciapetta of Socony-Vacuum Oil Company has received the Precision Scientific Company Award in Petroleum Chemistry. The award, consisting of $1000 and a certificate, was presented by the American Chemical Society at its national meeting held earlier this month in Cincinnati, Ohio.

Dr. Ciapetta, who is a research associate in charge of Socony-Vacuum's catalytic group, was cited for his "significant contributions to the basic knowledge of catalytics and to the petroleum industry in general." He developed a new class of platinum-acidic oxide catalysts.

His research led to the development of two commercial processes employing catalysts to raise the octane rating of low-grade naphtha. The Atlantic Refining Company's Catforming process is in use at a number of oil refineries and the Sovaforming process of Socony-Vacuum is expected to be in operation soon.

The petroleum industry award was established in 1948 by the Precision Scientific Company "to recognize, encourage and stimulate research achievements in the field of petroleum chemistry in the U. S. and Canada."

A member of ACS since 1939, Dr. Ciapetta presented as his award address a discussion of "The Reactions of Pure Hydrocarbons in the Presence of Dual Functional Catalysts." The address was made before the society's Division of Petroleum Chemistry.

Dr. Ciapetta joined Atlantic shortly after he received his master's degree from Temple University in 1939. Assigned as a junior chemist to the company's Research and Development department in Philadelphia, Pa., he enrolled at the University of Pennsylvania to continue studies toward his doctorate.

After receiving his Ph. D. in 1947, he was named as senior chemist and the following year, was placed in charge of Atlantic's catalyst process group. In 1950, he was named as principal chemist.

He joined Socony-Vacuum's Research and Development department in 1951. From 1947 to 1952, he served as an instructor in the evening college at Drexel Institute of Technology.

Paul B. Geiser has been promoted to market development representative for Continental Oil Company's Petrochemical department, with headquarters in Houston. Formerly superintendent of Conoco's petrochemical plant in Chicago, he is succeeded by K. R. Gerhart, who was assistant superintendent.

Geiser joined Conoco in 1948 as a chemical engineer at the company's Baltimore, Md., plant. He was promoted to coordinator of technical services for the Petrochemical department in 1951 and the following year was made superintendent of the Chicago plant.

Gerhart became associated with Conoco in 1947 at Baltimore. He was named supervisor of the company's sales service laboratory at Baltimore in 1952 and the following year was promoted to assistant superintendent at Chicago.

Howard G. Fillhower has been appointed manager of Tide Water Associated Oil Company's Employe Relations department, with headquarters in San Francisco, Calif. Fillhower joined the company in 1945 as supervisor of employe relations at the Bayonne, N. J., refinery.

Leonard L. Youell has been elected vice president and general manager of Stone & Webster Canada, Ltd., with headquarters in Toronto.

Youell

Youell joined Stone & Webster in 1945 to be its engineering representative to Canada, and when the Canadian firm was organized in 1950, he was named to head the Toronto office. A native Canadian, he spent six years in engineering in Canada and 19 years in the chemical industry in the U. S.

Robert L. Kylander has been promoted to staff engineer for Continental Oil Company's Petrochemical department, with headquarters in Houston. Formerly process and sales service engineer at Conoco's Baltimore, Md., petrochemical plant, Kylander is succeeded by Robert E. Maples, who was transferred from Ponca City, Okla.

Kylander joined Conoco in 1949 as an analytical chemist at Ponca City, later serving as a technologist and process engineer there before he was transferred to

What's Happening. . .

Baltimore in 1953. He received a master's degree in chemical engineering in 1947 from Oklahoma A & M College.

Maples became associated with the company last year. Previously, he served two years in Brazil as a consultant to the Brazilian government's petrochemical agency and two years as an instructor at the University of Tulsa, where he received his master's degree in chemical engineering in 1947.

R. L. Johnson, who was manager of the Refining department for Sunray Oil Corporation at Tulsa, Okla., has been transferred to the company's refinery at Duncan, Okla.

Nelson Lee Smith, Federal Power commissioner, will retire from public life when his term expires June 22. He will be succeeded by William R. Connole, general counsel for the Connecticut Public Utilities Commission.

Smith, who will have served almost 12 years on the commission, was chairman of the New Hampshire Public Service Commission for 10 years before he was named to the U. S. post in 1943.

Fred Case, formerly general manager of the Williston Basin Refinery, Inc., at Williston, N. D., has been named general manager of the Queen City Oil & Refining Company plant at Dickinson, N. D. He succeeds Chester Brooks, who resigned.

Case entered the oil business 29 years ago at Enid, Okla., and has been associated with refineries at Blue Island, Ill., and Coffeyville, Kan.

Kobe

Arnold

Drs. Charles W. Arnold and Kenneth A. Kobe have won a prize for the best Ph.D. thesis on chemistry or chemical engineering in the U. S. The award, to be granted this year for the first time, was announced by Phi Lambda Upsilon, honorary chemical society.

The title of the thesis is "A Thermodynamic and Spectroscopic Study of Ethylene Oxide."

Dr. Kobe, professor of chemical engineering at the University of Texas, has contributed many articles to the Petroleum REFINER. He is co-author of an article on urea complexes appearing in this issue on page 128, along with his biographical sketch.

Dr. Arnold, now with The Humble Oil & Refining Company, studied physics, mathematics and chemical engineering at the university, receiving his doctor's degree there in 1954. He taught physics and mathematics for six years while he pursued graduate studies.

Drs. Arnold and Kobe co-authored an article in the REFINER in April, 1951. An article, to be prepared from the award-winning thesis, will be published in a coming issue.

E. Lindsay Semple has been named vice president and manager in charge of crude purchasing for Great Northern Oil Company, which is building a $25-million refinery at Pine Bend, Minn., near St. Paul. Semple formerly was with Interstate Oil Pipe Line Company, a Standard Oil Company (New Jersey) affiliate, at Shreveport, La.

Paul E. Kuhl, assistant general manager of manufacturing for Esso Standard Oil Company, has been named general manager of the Abadan refinery on a two-year loan assignment to Iranian Oil Refining Company.

Kuhl joined the company in 1926 and subsequently served as assistant superintendent of its Aruba refinery, associate manager of Standard Oil Development Company's Process division and assistant manager for East Coast manufacturing. He served a year as director of foreign refining for the Petroleum Administration of Defense.

Dr. Norman Wright, representing The Dow Chemical Company at Midland, Mich., has been appointed chairman of a new society recently formed to further infrared spectroscopy. The group has taken the name, Coblentz Society, in honor of William W. Coblentz, retired chief of the Radiometry section of the Bureau of Standards and pioneer in infrared spectroscopy.

Wright's appointment was made by the Executive Board of the Committee on Infrared Spectroscopy formed at Columbus, Ohio, last summer at the Ohio State Conference on Molecular Structure and Spec-

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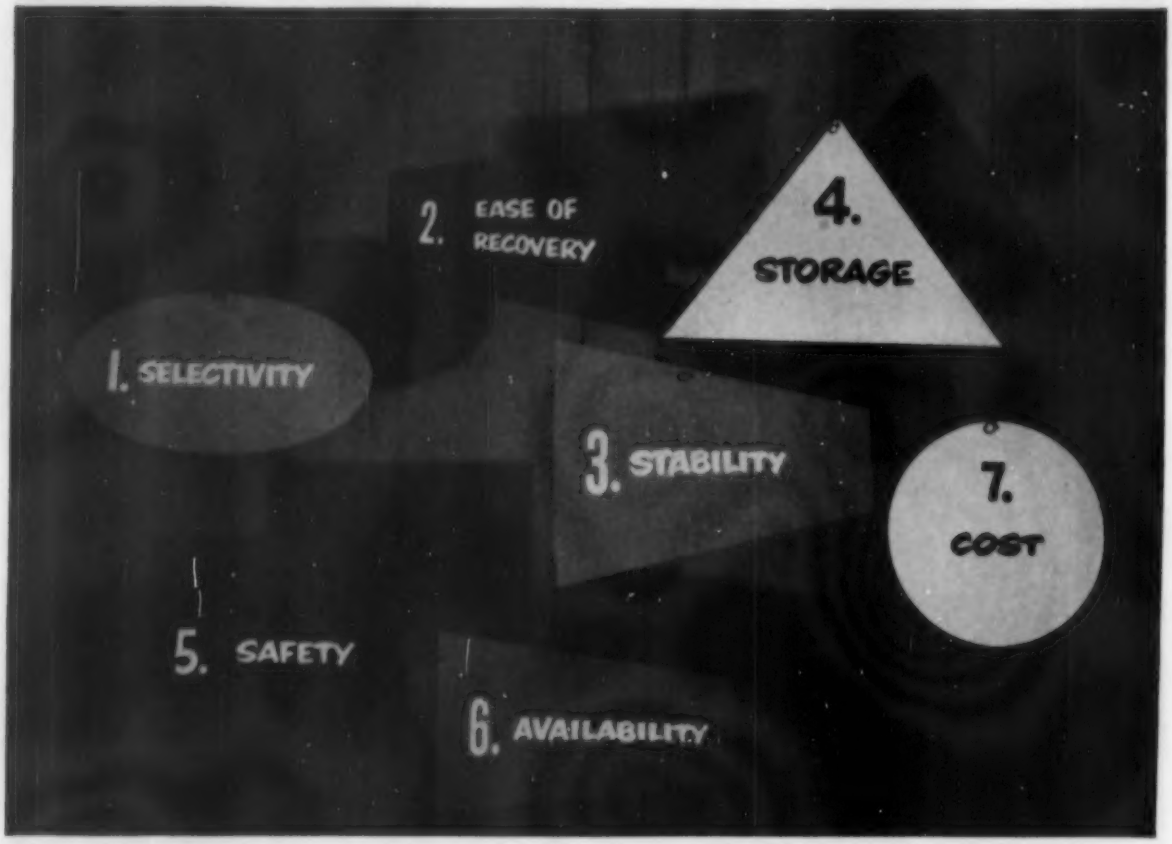

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troscopy. Members of the board: Dr. Van Zandt Williams, The Perkin-Elmer Corporation, Norwalk, Conn., registrar; Howard Cary, Applied Physics Corporation, Pasadena, Calif.; Dr. Bryce L. Crawford, Jr., School of Chemistry, University of Minnesota; Dr. R. A. Oetjen, Department of Physics and Astronomy, Ohio State University, and Dr. E. J. Rosenbaum, Sun Oil Company, Norwood, Pa.

John A. Scott has been elected president of Sinclair Chemicals, Inc. Executive vice president and a director of Sinclair's petrochemical subsidiary since 1952, he was to have taken over his new position immediately.

Scott joined the Sinclair organization as a research technologist with Sinclair Refining Company in Chicago in 1934, held a number of important research positions and from 1945 to 1951 served as assistant to the vice president in charge of research and development. When the refining company formed its Petrochemical division in 1951, Scott was named as division manager, advancing to his recent post when the petrochemical company was established a year later.

Scott

In addition to his post as head of the chemical company, Scott also is a director of Sinclair Research Laboratories, Inc., and a director of Calumet Nitrogen Products Company.

E. W. Berlin has been appointed general representative for Standard-Vacuum Oil Company's subsidiaries operating in Indonesia. Stationed at Djakarta, he succeeds G. L. McCoy who, after a tour of Stanvac operations in the Far East, has returned to the company's New York headquarters for reassignment.

Berlin, special advisor to McCoy in Indonesia for more than two years, has had 29 years in the petroleum industry, 26 of which have been in the international field. He went to Indonesia first in 1929 to help develop Stanvac's South Sumatra fields and remained there until the outbreak of World War II, in which he served as the Army's area petroleum officer for the China-Burma-India Theater.

Robert O. Faris, formerly production engineer for The Atlantic Refining Company at Odessa, Texas, is now a petroleum engineer with National Cooperative Refining Association at Great Bend, Kan.

L. C. Borell has been made manager of the L. Sonneborn Sons, Inc., refinery at Franklin, Pa. Formerly technical director of the refinery, Borell replaces Charles H. Goss, who recently retired.

Borell joined the Sonneborn organization in 1942 as a research chemist in its refinery at Petrolia, Pa. He was transferred to the Franklin operation in 1944 as chief chemist.

C. C. Crawford has joined the staff of Husky Oil Company to conduct studies in petrochemicals. He formerly was president of Crawford Chemical Company in Bartlesville, Okla.

Before organizing his own firm, Dr. Crawford was president of a Phillips Petroleum Company subsidiary. A graduate from Arkansas College, he holds a M.S. degree in chemistry from Emory University and a Ph. D. from Yale University.

O. M. Meador has been promoted to chief accountant at The Humble Oil & Refining Company refinery at Baytown, Texas.

Meador

A University of Arkansas graduate, Meador has held various accounting positions since he joined Humble in 1939. Since 1948, he has been with the Material Accounting division at Baytown, except for a year in the Controllers division in Houston.

Marion W. Boyer, executive vice president of Esso Standard Oil Company, will be proposed for election as a director of Esso's parent company, Standard Oil Company (New Jersey). His name will be submitted to shareholders, along with the names of 13 present members of the Jersey board who will be nominated for re-election.

What's Happening . . .

J. M. Wilson, assistant superintendent at Shell Oil Company's refinery in Wood River, Ill., has been transferred to a similar position at the Wilmington, Calif., plant. He will be replaced at Wood River by A. C. Hogge, formerly chief technologist.

Other changes in the organization at the Illinois refinery call for the promotion of A. J. Wood, former manager of the Alkylation department, named to replace Hogge

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What's Happening. . .

as chief technologist. Wood will be succeeded by S. F. Good, transferred from the Norco, La., refinery, where he was Gas department manager.

Also transferred to Wood River from Norco is J. R. Noles. Formerly manager of the Stores department at Norco, he replaces C. A. Bearden, who retired.

R. K. MacIntyre, transferred from Wilmington where he was assistant chief engineer, has taken up a similar position at Wood River. He succeeds Allen Collins, who was promoted to assistant personnel manager at Shell's offices in New York.

W. S. Myers, formerly manager of the Gas department at Wood River, has taken over as manager of the refinery's Dispatching department. He was succeeded by J. A. Marshall, previously assistant manager of the Aromatics department. R. A. Fischer, a technologist in aromatics, was promoted to assistant manager of the department.

B. W. Pickard has been elected president of The California Oil Company. In taking charge of the East Coast subsidiary of Standard Oil Company of California, he replaces E. W. Endter, who recently resigned.

From 1947 until he became assistant general sales manager for the West Coast company in 1951, Pickard served as assistant to the vice president. During this period, in which he also served as vice chairman of the board, Pickard was concerned primarily with sales to the military and other government agencies.

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R. C. McCurdy, president of Shell Chemical Corporation, has been elected to the board of Shell Oil Company.

McCurdy

President of Shell's chemical company since 1951, McCurdy joined the Shell organization shortly after his graduation from Stanford University in 1933. He served as exploration engineer at Los Angeles, New York and Washington, and in 1945 was appointed manager of the production division at San Joaquin, Calif.

He joined a Shell group company in Venezuela in 1947 and became general manager there in 1950.

John G. Walmsley has been promoted to mechanical engineer in the Maintenance department of The Humble Oil & Refining Company's Engineering division at the refinery in Baytown, Texas.

Walmsley joined Humble shortly after he left the Army in 1947. Formerly an engineer in the department, where he had become a specialist in pumps, compressors and other mechanical equipment, he will take charge of testing equipment and recommending maintenance and changes.

Walmsley is a frequent contributor to PETROLEUM REFINER.

Earl M. Beebe has been appointed refinery manager for Champlin Refining Company at Enid, Okla. The company is a wholly-owned subsidiary of The Chicago Corporation, with operation offices in Fort Worth, Texas.

Beebe

Beebe formerly was superintendent of Peppers plants in Oklahoma City, and before joining Peppers in 1935, he worked at the Kanotex refinery in Arkansas City, Kans.

Phillips C. Salman has been appointed comptroller by Socony-Vacuum Oil Company, Inc. Assistant comptroller since 1945, he replaces Louis E. Hanson, who retired.

Salman joined a predecessor company of Socony-Vacuum in 1919, and transferred to the company's New York headquarters in 1933 as assistant credit manager. He was made general auditor in 1942 and became assistant comptroller in 1945.

He is general chairman of the Financial and Accounting committee for American Petroleum Institute and served as chairman of the API subcommittee which issued an outline of accounting for the petroleum industry in 1954.

Deaths—

Boyd H. Carr, Sr., who retired in 1953 after serving 38 years with The Dow Chemical Company, died March 1 at Tucson, Ariz.

Don Jacobs, technical adviser to Mid-Continent Petroleum Corporation at its West Tulsa, Okla., refinery, died March 11, following a heart attack. He was 61 years old.

B. F. Green, Sr., former comptroller of Franks Manufacturing Company, died March 10 after suffering a stroke at his home in Sarasota, Fla.

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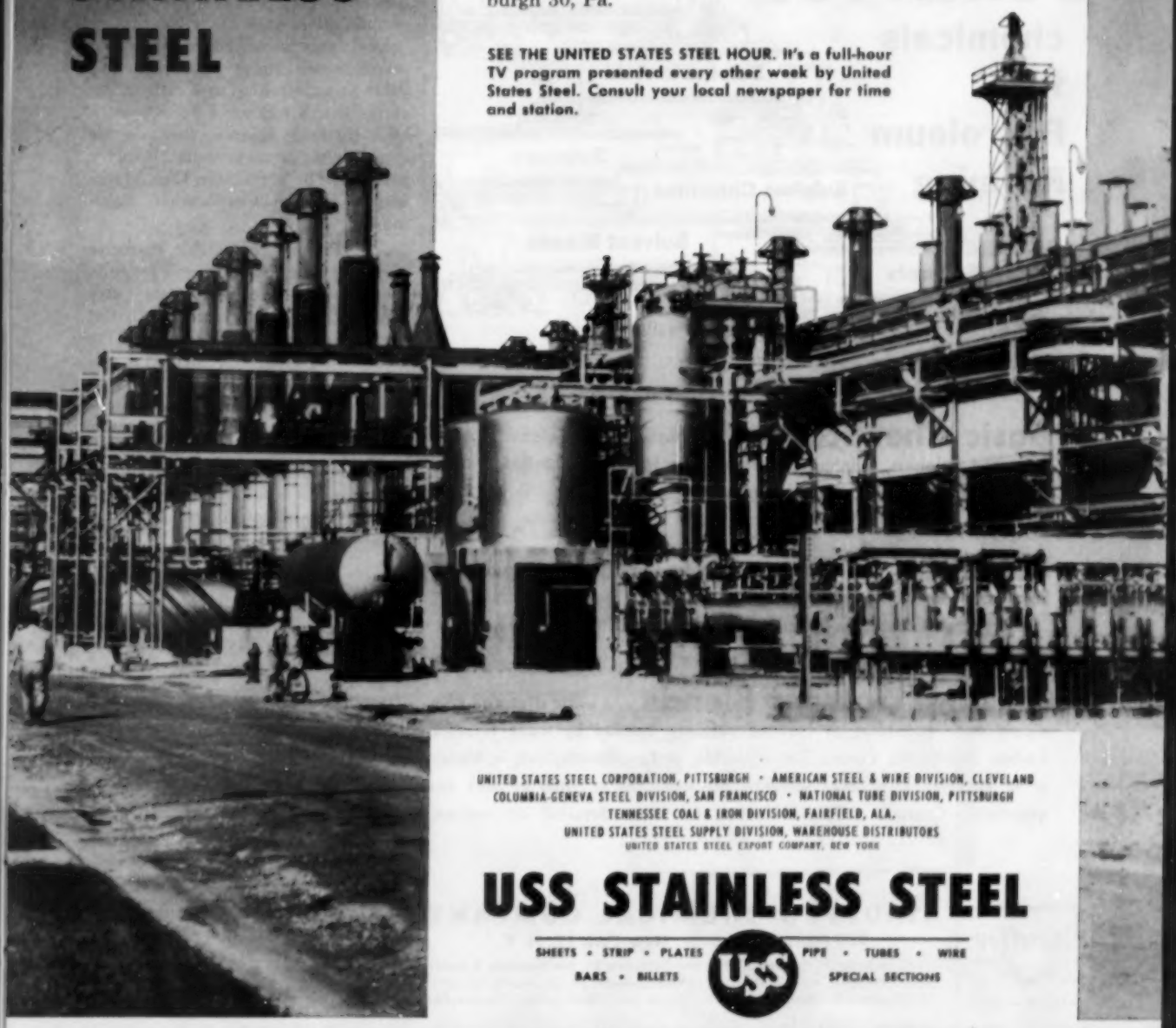

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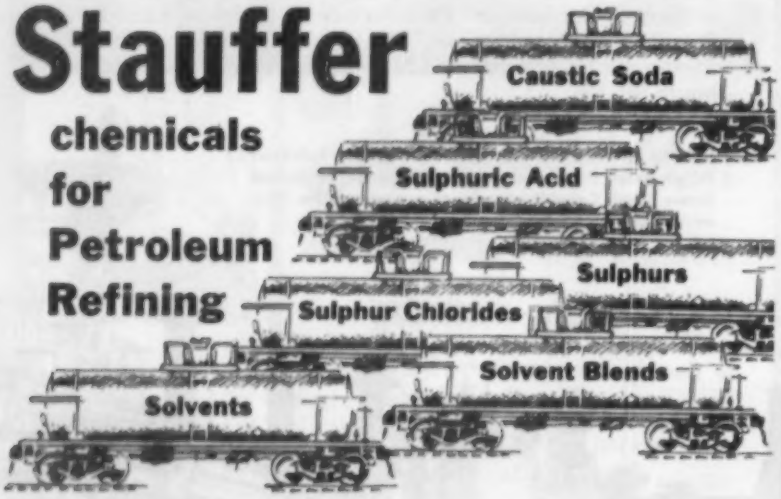
* NACE at Chicago.

Stauffer

chemicals for Petroleum Refining



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. . . **A corrosion** engineer's work is both corrective and preventive. Doing better preventive work lessens corrective work required. A wide knowledge of materials and fabrication with good specifications to cover both is required of the corrosion engineer. Frequently a corrective corrosion or metals problem is the heart of an engineering problem. When a specific problem is isolated, the engineering problem usually must be solved before the materials problem. A simple substitution of materials of construction frequently is inadequate. By the accumulation and distribution of helpful preventive information, the corrosion engineer establishes his value as a consultant and recognition of his worth follows. Effective work by a corrosion engineer can save his company ten times or more his salary per year. (B. J. Philbert, Olin Mathieson Chemical Corporation, Baltimore.)

. . . **Presence** of soluble corrosive agents in asbestos braid and graphite lubricant apparently causes valve stem pitting. Tests were conducted at three locations using various packing treatments, graphites, sacrificial elements and inhibitors. Valve stem material was Type 416. Test results indicate that removal of soluble corrosive constitutents, incorporation of inhibitors or sacrificial elements and careful selection of graphite dry lubricant in packing manufacture are beneficial and necessary.

Nitrogen Useful In Working Aromatics

. . . **Nitrogen**-containing solvents are very effective in separating aromatics from aliphatic hydrocarbons. Three such solvents, diethanolamine, triethylenetetramine and 2-anilinoethanol, have proved to be superior to solvents in current use. (William B. Hughes and Wayne S. Fallgatter, Cities Service Research and Development Company, Tulsa, Okla.)

. . . **Compounds** containing phosphorus will probably be the most effective preignition controlling gasoline

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additives. Results of tests on 21 lead compounds discloses that the lead orthophosphate and lead pyrophosphate have no tendency toward causing preignition conditions. Nineteen of the other compounds showed unfavorable characteristics. George J. Nebel and Paul L. Cramer, Research Laboratories, General Motors Corporation, Detroit, Mich.)

. . . **Octane** number of the gasoline blend cannot always be predicted from the octane numbers of the various components in the blend. The major factor affecting the antiknock qualities of hydrocarbons may be the octane level or engine severity at which the blends are rated. Prereactions in the engine which occur prior may be the basic cause of octane blending anomalies. (Forest H. Blanding, Standard Oil Development Company, Linden, N. J.)

. . . **Naphthas** contaminated with various nitrogen, oxygen, sulfur and olefinic compounds can be purified by catalytic reduction of the contaminants. Under the most severe conditions, over 98 percent removal can be accomplished by hydrogenation of the naphtha over a cobalt-molybdenum-alumina catalyst. (A. J. deRosset, F. J. Riedl, G. J. Czajkowski, Universal Oil Products Company, Des Plaines, Ill.)

. . . **Conversions** of 85 percent per pass and yields above 98 percent were obtained in the preparation of methyl mercaptan from methyl chloride, aqueous hydrosulfide, and hydrogen sulfide. Best results were obtained in this semipilot reactor with operating conditions of 158 F. and 175 psig. in a coil reactor with contact time of 11 minutes. (C. B. Scott, W. S. Dorsey, H. C. Huffman, Research Division, Union Oil Company of California, Brea, Calif.)

Needs 5 Percent of Uranium Supply*

. . . **Projected** energy requirements for the next 50 years amount to less than 0.5 percent of the uranium or 5 percent of the thorium reserves. Present technology indicates, however, that most of the energy from nuclear sources will be utilized for the generation of electricity in stationary power plants. Under certain conditions such as coal cost at $7 per ton and uranium cost at $35 per pound and 80 percent load factor, nuclear power can compete effectively at an electrical power cost of 7 mils per kilowatt hour. (R. V. Andrews, Texas A & M College, College Station, Texas.)

. . . **The most** important single feature of polyethylene structure is the relationship between degree of branching and crystallinity. The more branches in the polyethylene molecule, the lower the crystallinity. The stiffness and yield point are independent of the molecular weight and both are increased as crystallinity is increased. The result—flexibility and toughness of polyethylene can be increased by the production of polymers with fewer branches. (F. P. Reding, Carbide & Carbon Chemicals Company, S. Charleston, West Virginia.)

. . . **Production** of polyvinylchloride resins will top 10,000,000 pounds this year. Acceptance of rigid PVC has been slow because of difficulty in processing it and because of the long development period which has been required to prove its properties in certain applications. (K. K. Fligor, Goodyear Tire and Rubber Company, Akron, Ohio.)

* AIChE-ACS Sectional Beaumont, Texas, March 4

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MEETINGS CALENDAR

APRIL	
13-15	National Petroleum Association (52 Semi-Annual Meeting), Cleveland Hotel, Cleveland.
13-15	Natural Gasoline Association of America (Annual Convention), Baker and Adolphus Hotels, Dallas, Texas.
13-15	American Society of Lubrication Engineers (Annual Meeting and Lubrication Exhibit), Hotel Sherman, Chicago.
13-15	National Petroleum Association (Semi-Annual Meeting), Hotel Cleveland, Cleveland, Ohio.
16	American Society of Mechanical Engineers (Organization Anniversary Meeting), Hoboken, N.J.
17-19	American Oil Chemists Society (National Meeting), Roosevelt Hotel, New Orleans, La.
18-19	Third National Air Pollution Symposium, Pasadena, Calif.
18-20	American Society of Mechanical Engineers (Spring Meeting), Lord Baltimore Hotel, Baltimore, Md.
19-21	Southwestern Gas Measurement Short Course, University of Oklahoma, Norman, Okla.
20-22	Petroleum Industry Electrical Association (Annual Conference), Shamrock Hotel, Houston.
24-27	American Society of Mechanical Engineers (Region VIII Engineering Conference), Rice Hotel, Houston.
28-29	Rocky Mountain Oil & Gas Association Refining Committee (Annual Meeting), Cosmopolitan Hotel, Denver.
MAY	
1- 4	American Institute of Chemical Engineers, Shamrock Hotel, Houston.
1- 4	Liquefied Petroleum Gas Association (Annual Convention), Conrad Hilton Hotel, Chicago.
2- 4	American Petroleum Institute (Evaporation Loss Committee and Subcommittee Meetings), Edgewater Beach Hotel, Chicago.
5	National Petroleum Council, Washington, D.C.
9-10	American Gas Association (Gas Supply, Transmission, Storage Conference), Wm. Penn Hotel, Pittsburgh.
9-12	American Petroleum Institute (Division of Refining, Midyear Meeting), Jefferson Hotel, St. Louis, Mo.
14-22	World Wide Chemical Plant and Equipment Exposition and Congress, Frankfurt, Germany.
16-18	American Petroleum Institute (Division of Marketing, Lubrication Committee), The Greenbrier, White Sulphur Springs, W. Va.
16-20	National Fire Protection Association, Netherlands Plaza Hotel, Cincinnati, Ohio.
18	Chemical Market Research Association (Annual Business Meeting), Hotel Plaza, New York.
23-27	Conference on Mass Spectrometry, Sponsored by American Society for Testing Materials Committee E-14, Mark Hopkins Hotel, San Francisco.
26-27	Western Petroleum Refiners Association (Regional Technical-Industrial Relations Meeting), Settles Hotel, Big Spring, Texas.
30-June 1	Chemical Institute of Canada (38th Annual Conference and Exhibition), Quebec City, Canada.
JUNE	
1- 3	Short Course in Gas Technology, Sponsored by Texas College of Arts & Industries, Kingsville, Tex.
5- 9	Canadian Gas Association (Annual Meeting), Sheraton Broeck Hotel, Niagara Falls, Ont., Canada.
6-15	Fourth World Petroleum Congress, Rome, Italy.
9-10	Natural Gas & Petroleum Association of Canada, Royal Connaught, Hamilton, Ont., Canada.
12-17	Society of Automotive Engineers Golden Anniversary Summer Meeting, Chalfonte Haddon Hall, Atlantic City, N.J.
20-23	American Society of Mechanical Engineers, (Semi-Annual Meeting), Statler Hotel, Boston, Mass.
23-24	Western Petroleum Refiners Association (Regional Technical-Industrial Relations Meeting), Broadview Hotel, Wichita, Kansas.
26-July 1	American Society for Testing Materials Committee D-2, Petroleum Products and Lubricants, Chalfonte Haddon Hall, Atlantic City, N.J.

Reviewing New Books . . .

British Publish New Standards Edition

Standard Methods for Testing Petroleum and Its Products.

This is the British equivalent of the American **ASTM Standards on Petroleum Products and Lubricants.** The book closely follows the suggestions for method arrangement given in "Recommendations on the Form of ASTM Methods," which are as follows:

Title and serial designation, scope, definitions, outline of method, apparatus, materials, precautions, preparation of sample, preparation of apparatus, procedure, calculation and reporting, and precision.

The book contains all the standard methods on conventional petroleum products, except for engine test methods for rating fuels (see below). (Fourteenth Edition published by The Institute of Petroleum, 26 Portland Place, London, W. 1, 40 shillings, about $2.60.)

IP Engine Test Methods for Rating Fuels.

This manual supplements the book above. For the first year, it has been published as a separate publication because the increasing size of "Standard Methods." It contains the methods for determining the knock rating of motor and aviation fuels and ignition quality of diesel fuels. (The Institute of Petroleum, 26 Portland Place, London, W. 1, 1 pound, about $2.80.)

Higher Mathematics

Advanced Mathematics for Engineers, Third Edition, by H. W. Reddick and F. H. Miller.

Just published in the third edition, this book offers sound mathematical principles together with concrete examples of how to use higher mathematics in the practice of engineering.

Revised by Professor Miller, the book retains the useful features of earlier editions and has been expanded to cover other subjects more fully. It covers those principles of mathematics which are essential for an understanding of current developments in engineering theory and practice, making a careful presentation of definitions, statements of physical laws, theorems, problems and the physical units used.

The work continues to emphasize physical applications by providing problems related to the major fields of engineering. The problem list, expanded by almost 20 percent, is complete with answers.

The book opens with a chapter on the common types of ordinary differential equations. Further chapters give a comprehensive treatment of operational calculus, Fourier series, partial differential equations, vector analysis, elliptic integrals, gamma and Bessel functions and functions of a complex variable.

Included in the new material are discussions of Legendre's equation, numerical methods, Laplace trandforms and the reversion of power series.

(John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, 540 pp. $6.50.)

A Guide to Process Industries

Selected Process Industries, by R. Norris Shreve.

The manual gives the chemical engineer a broad picture of modern chemical processes in a generalized form, through the correlation into flow sheet and descriptive text of chemical and physical changes and reactions; economic statistics and costs, and energy and power required.

In both scope and viewpoint, the book follows closely modern factory practice and shows actual industrial procedures. Illustrated by hundreds of tables and flow sheets, with integrated information on raw materials, equipment, cost and markets, the book offers typical problems to test one's grasp of industrial principles. Classified, it gives a quick, easy look at each industrial process.

(McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, 842 pages, 240 illustrations, $7.50.)

Patent Law in Research

Patent Law in Research Laboratories, by J. K. Wise.

This book gives the industrial research worker a practical insight into the work-

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New Books . . .

ings of the patent system and shows him clearly the impact of that system on the day-to-day research activities.

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(Reinhold Publishing Corporation, 430 Park Avenue, New York 22, New York. Price $2.95.)

Simplified Version

Interpretation of Engineering Data: Some Observations, by Harold S. Dodge.

This is a fundamental yet simplified version of statistical methods in quality engineering. The author tries to point up some of the techniques used in quality control as they are important in planning for the collection of data and interpretation as well. Particular attention is given to applications of some of the simpler statistical methods.

Typical headings in the booklet are: "A Sampling Technique, Quality as a Frequency Distribution, Sample and Universe, Frequency Distributions as an Aid to Interpretations, Estimates and Confidence Limits, Control Chart Method of Controlling Quality, and How Large a Sample." Origin of the booklet was the Edgar Marburg lecture given by Dodge at the annual meeting of the ASTM, held in June 1954 at Chicago. (American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Penn. Price $1.50.)

Instrumental Methods

Instrumental Methods of chemical Analysis, by Galen W. Ewing.

Chemical analysts will be able to take better advantage of the possibilities of instrumental methods with the help of this long-range survey. Stressing the possibilities and limitations inherent in various instrumental techniques, the book describes available methods in detail, relating them to theory. Theoretical background is outlined without using highly involved mathematics.

The book covers such advances as high frequency titrations, differential colorimetry and modern spectrometry methods. A new graphical method for selecting deposition potentials is introduced. Included also are methods which while not strictly instrumental, deserve coverage in a survey such as this.

(McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, 436 pp., 305 illustrations, 36 tables, $6.50.)

API Issues Supplements On Centrifugal Pumps

Supplements 1 and 2 to API Standard 610, Specification for Centrifugal Pumps for General Refinery Services, have been issued by the American Petroleum Institute.

Supplement 1 pertains to mechanical shaft seals for use in centrifugal pumps for general refinery service, and covers the design and suitable materials for the service conditions specified for the pumps.

Supplement 2, covering vertical process pumps, modifies API Standard 610 to make it applicable to vertical process pumps including single- and double-casing types.

Like all API publications, the supplements are available to interested parties for 25 cents each. Orders should be mailed to American Petroleum Institute, 50 West 50th Street, New York 20.

Mass Spectrometry

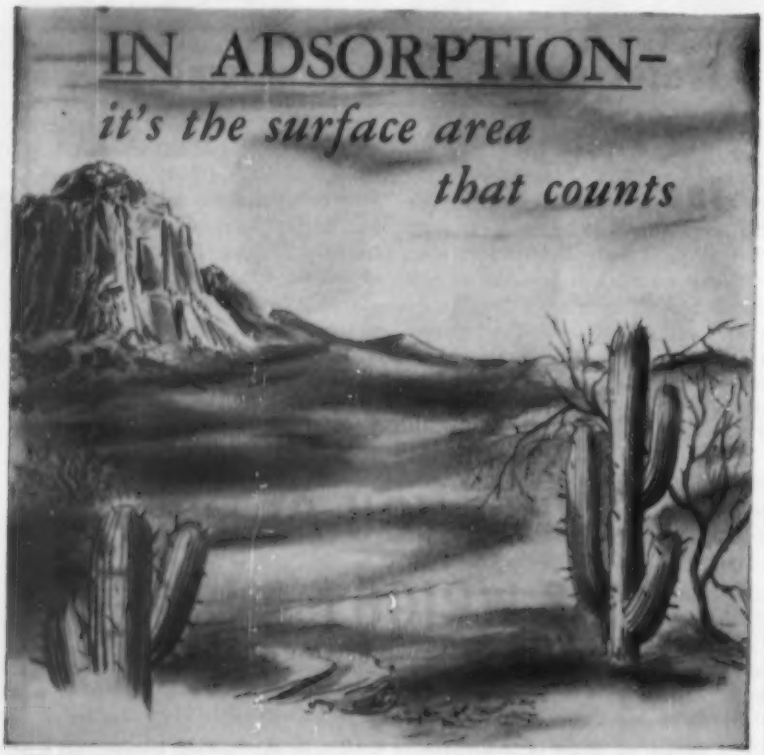
Applied Mass Spectrometry.

This book brings together a large number of British scientists, each an expert in his own field of mass spectrometry. Subject matter is divided according to general applications, specific analytical applications, applications to fundamental problems, instrument developments and computing methods.

Typical chapter headings under general applications: "Mass Spectrometry as an Analytical Tool," "Application of High Molecular Weight Mass Spectrometry to Oil Constitution"; and "Application of the Mass Spectrometer to the Analysis of Solid Materials."

The origin of the book is the Conference on Applied Mass Spectrometry, held in London in October, 1953, and organized by the Mass Spectrometry Panel of the Institute of Petroleum. Each chapter represents a paper from this conference.

(The Institute of Petroleum, 26 Portland Place, London, W. L., 333 pp., 2 pounds 10 shillings, about $7.)



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What Suppliers Are Doing . . .

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John J. Brennan has been appointed as sales engineer for **Maintenance Engineering Corporation** in Houston. He formerly was associated with National Aluminate Corporation of Chicago.

James L. Dillon also has been named as a Maintenance Engineering Corporation sale engineer. Dillon joins the Houston firm after a year with Texas State Board of Water Engineers.

Frank B. Kreider has been selected as general sales manager for **Union Asbestos & Rubber Company's** Fibrous Products division. Prior to joining Unarco, Kreider served as general sales manager of Darling Valve and Manufacturing Company in Williamsport, Pa.

J. P. Stewart, president of **De Laval Steam Turbine Company**, has been elected a member of the National Industrial Conference Board. The selection was made recently at the board's 156th annual meeting held in New York.

Dean A. Maris has been appointed as a sales engineer for **OPW Corporation.** He will serve in an advisory capacity to district managers and jobbers marketing OPW products in the oil and chemical industries.

Max Knopp has been chosen as export manager for **Enterprise Engine & Machinery Company**, a subsidiary of General Metals Corporation of San Francisco, Calif. He will make his headquarters in the Enterprise offices in New York.

Frank B. Huke has been appointed chief atomic products engineer for the Refractories division of **Norton Company.** He joined Norton last year after several years experience in the atomic field, including participation in the Army's "Manhattan District" project.

Robert F. Lay, former assistant general sales manager for **The Cooper-Bessemer Corporation**, has been elevated to the general sales manager's position. Named to serve as his assistant is Grant C. Woodard, former sales engineer.

Dale W. Blanton heads a list of four new appointments in the sales organization of **Enterprise Engine & Machinery Company**, a subsidiary of General Metals Corporation. Named with Blanton, who becomes manager of contract engineering, are Robert A. Thompson, new senior contract engineer; George Heuer, contract engineer, and Austin B. Crouchley, who takes the post of sales engineer working out of the New York office.

Dunlap | Pruden | LauBach | Tullo | Gerbereux | McGuirk | Willes | Maitland | O'Conner

Dr. L. H. Dunlap has been promoted to manager of the Chemical department at **Armstrong Cork Company's** Research and Development Center in Lancaster, Pa. Former assistant manager of the department, Dunlap succeeds Dr. E. J. Pieper, who retired after 34 years with the Armstrong organization.

Bradlee Pruden has been elected vice president in charge of engineering for **Ric-wiL, Inc.**, Barberton, Ohio, insulated pipe supplier. Formerly associated with Giffels & Vallet, Inc., and L. Rosetti, Pruden had served the past five years as chief mechanical engineer.

Neal B. LauBach, manager of the Cooling Equipment department of **Hudson Engineering Corporation**, a Houston firm, has been re-elected president of the Cooling Tower Institute. Other officers elected for 1955 terms are **Paul R. Hoffman, Lilie-Hoffman Cooling Towers, Inc.**, St. Louis, Mo.; vice president; **Clayton E. Pickup, The Fluor Corporation, Ltd.**, Los Angeles, Calif., secretary, and **Sidney Levine, Santa Fe Tank & Tower Company**, Los Angeles, treasurer.

Aloysius M. Tullo, workers manager of **Worthington Corporation's** works at Harrison, N. J., has been appointed general manager of a newly-created division to be known as the Harrison division.

Vincent Gerbereux has been chosen as general manager of a new Standard Pumps division, also recently-established at Harrison by the Worthington Corporation.

William E. McGuirk, Jr., executive vice president of **Davison Chemical Company** Division of W. R. Grace & Company, has been elected to the company's advisory board. A former officer in the Regular Navy and at one time associated with Kuhn, Loeb & Company, McGuirk also was an assistant to one of the members of the Atomic Energy Commission and was a vice president with W. R. Grace & Company before joining Davison.

W. D. Willes, former general manager of **Rockwell Manufacturing Company's** Nordstrom valve plants at Barberton, Ohio, and Oakland, Calif., has been named product manager for Nordstrom valves, with headquarters in Pittsburgh. He succeeds Orville W. Barnett, appointed manager of distribution and oil field sales.

John M. Maitland has been appointed manager of **The Bristol Company's** Detroit, Mich., district office. Formerly associated with North Range Mining Company and the DuPont organization, Maitland joined Bristol's sales staff in 1946. He will be transferred from New York.

D. T. O'Connor has been named as export representative for **Orbit Valve Company.** He headquarters in New York, representing manufacturers of petroleum equipment in South America, Europe, the Near, Middle and Far East.

Blaw-Knox Division Makes Six Promotions

Buflovak Equipment division, Blaw-Knox Company, has announced six new sales appointments:

Harold V. Williams, former sales manager of Blaw-Knox process equipment, was promoted to assistant sales manager of the Buflovak division, headquartered in Buffalo, N. Y. Robert H. Hazlett, who was assistant manager of the Process Equipment department, was made gas equipment sales manager at Buflovak.

Edgar L. Demarest, who represented the division in New York, is the new sales manager at Philadelphia. He will be assisted by Warren V. Eisenhuth, formerly

with the Process Equipment department.

Harold R. Kibby was promoted to head a new sales office at Birmingham, Ala. And George B. Phillips, formerly a process equipment sales engineer, was made sales representative for the division in Chicago.

Goree

Plehn

Bucyrus-Erie Makes New Sales Appointments

Edwin T. Goree has been assigned as assistant sales manager for Bucyrus-Erie Company's line of excavators. He will assist R. C. Adams, recently named sales manager following the promotion of L. E. MacDonald to general sales manager.

Another new appointment in the excavator sales organization went to John H. Plehn, who rejoined the company as a sales representative in the San Francisco area. Formerly associated with the company for 18 years, he had left Bucyrus-Erie late in 1953.

Plehn joined the company as a clerk and helper in 1935 and in 1940 was shifted from the steel foundry to the Parts division. He was transferred to the West Coast in 1945 as a clerk in the San Francisco area and four years later, was appointed area representative for tractor equipment, a position he held until the company quit selling that line.

Goree joined Bucyrus-Erie in 1947 and received special training in export sales. As a respresentative of the company, he traveled in Mexico, Central and South America and in 1951, was named field representative to Mexico.

New Chemical Company Formed in United Kingdom

Grange Chemicals, Ltd., a new company for the manufacture of detergent alkane, has been formed by Oronite Chemical Company, San Francisco, and British Petroleum Chemicals, Ltd., London.

The new company will commence operations on completion of its plant, now under construction at Grangemouth, England. The plant is scheduled to go into operation during the last quarter of 1955.

Leeds & Northrup Names Engineering Sales Head

A. E. Tarr, formerly manager of Leeds & Northrup Company's Sales Engineering division, has been appointed assistant to the president. He is succeeded by Harold L. Scutt, formerly sales manager of the New York district.

Nathan Cole, who was manager of the West Central sales region with headquarters in Chicago, also has moved to the main offices in Philadelphia where he is

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manager of the Market Development division. He replaces L. E. Emerich, recently named director of marketing.

H. Raymond Abey, who has been manager of the Eastern Sales region, is appointed manager of the Marketing Service division, succeeding A. Merrill Redding, who died recently. J. William Robinson, formerly manager of the Western Sales region, becomes western sales manager, with headquarters in San Francisco.

New Engineering Firm Organized in Kansas

Litwin Engineering Company has been organized as a Wichita, Kan., firm for designing and building refineries and gasoline and petrochemical plants. Harry Litwin serves as president of the new company.

Litwin

Associated from 1930 until recently with Winkler-Koch and later vice president of Koch Engineering Company, Litwin has spent considerable time in Europe managing refinery construction. He also is vice president and a director of Century Refining Company at Garden City, Kansas.

G. E. Furnishes Turbines for Gulf

Orders for mechanical-drive turbines and turbine-generator sets amounting to about $860,000 have been received by the General Electric Company's Small Turbine and Supercharger department in Fitchburg, Mass.

Included in the orders are two high-speed, multi-stage DRV turbines for Gulf Oil Corporation's new catalytic cracking units at its refinery in Port Arthur, Texas. Delivery for the turbines, which will drive centrifugal compressors, was set for August, 1955.

Dow Picks Torrance Head To Handle Plastics Operation

The Dow Chemical Company has appointed Dr. J. L. McCurdy as assistant manager of its Plastics Production department. Manager of the company's Styron plant at Torrace, Calif., since 1952, Dr. McCurdy will be in charge of Styron,

GUNITE
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CONCRETE
SAND AND CEMENT
"Placed by Air"

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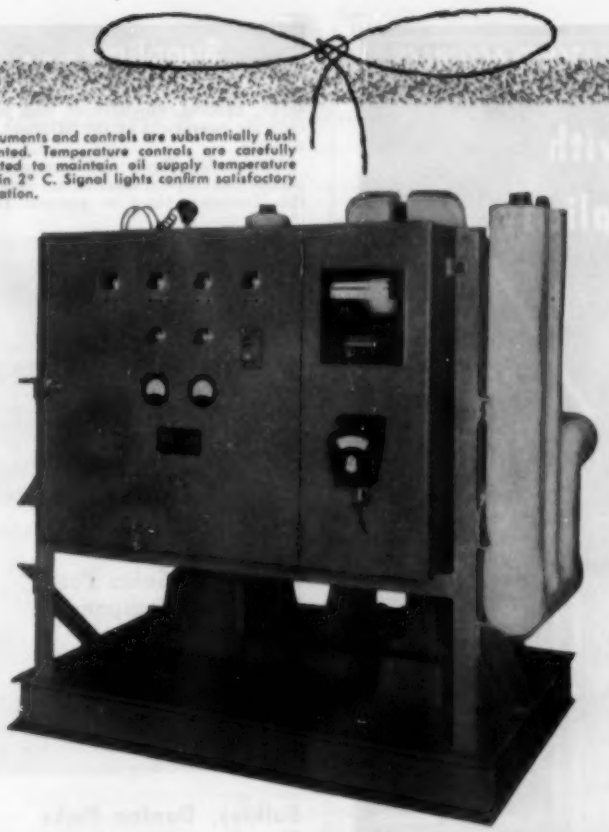
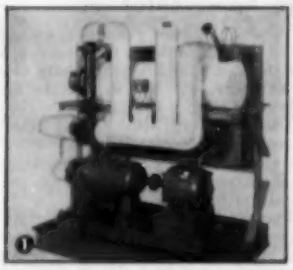
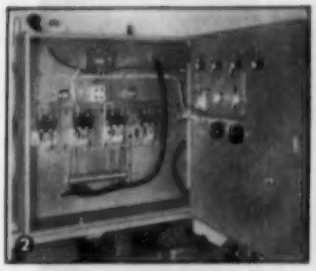
A COMPLETE TRANSFER OIL HEATING SYSTEM in one compact "PACKAGE"



Instruments and controls are substantially flush mounted. Temperature controls are carefully selected to maintain oil supply temperature within 2° C. Signal lights confirm satisfactory operation.



1. The system is compactly arranged to conserve space. To obviate leaks, pipe connections are welded wherever possible. The heavy pipe insulation is securely wired and wrapped with cemented canvas.



2. The workmanlike electrical system provides easy-to-trace circuits. All wire of high current capacity is heavy cross section.

WHITLOCK has developed a standard "package", with ratings of 10 to 50 KW, which includes heater operating controls and expansion tank to heat chemically stable transfer oils. Since these oils are liquid over considerable temperature ranges, they are being used increasingly in chemical processing operations. The heating equipment, previously of special design, is now available as a complete, standardized unit to which only oil and electrical connections need be made in order to permit immediate operation.

The combination of low liquid pressures and high liquid temperatures eliminates the need for the application of high pressure design techniques to many current processes. This new "package" effectively serves to reduce overall equipment costs and to simplify process design.

For additional information and prices, write The Whitlock Manufacturing Company, 75 South Street, West Hartford 10, Conn. In Canada: Darling Brothers, Ltd., Montreal.

Whitlock

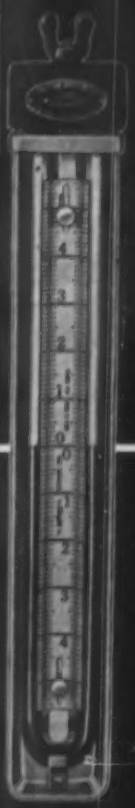
Designers and builders of bends, coils, condensers, coolers, heat exchangers, heaters, piping, pressure vessels, receivers, reboilers

For more data on advertised products, use Readers' Service Cards, last page.

UNMATCHED ACCURACY

with simplicity and economy

AT LOWEST COST . . . this Meriam Manometer offers high accuracy. The Meriam B-1103 is the easy-to-use, always dependable form of pressure or flow instrumentation. Pressures to small fractions of an ounce are read directly, accurately . . . without calibration or instrument adjustment . . . with complete enduring manometer reliability.



★ Rugged cast alloy construction

★ Convenient manometer cleanout

★ Curved scale for increased readability

★ Designed for easy panel mounting

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Meriam Manometer Instrumentation ...for pressures, vacuums, flows, liquid levels.

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Suppliers . . .

saran, Ethocel, vinyltoluene and polyvinyl chloride operations at the Midland, Mich., division.

Daniel W. Ryan was promoted from production superintendent to manager of the Torrance plant to succeed Dr. McCurdy.

Braznell

Fundis

Named to Sales Posts With Key Company

Bart R. Braznell has been appointed sales manager for Key Company, East St. Louis, Ill., equipment company. He will be assisted by L. J. Fundis.

Braznell and Fundis each have a background of more than 20 years' service in the engineering, manufacturing and sales divisions of the Key organization.

Bulkley, Dunton Picks Five Representatives

Bulkley, Dunton Processes, Inc., has selected J. L. Middleton Company, a Miami, Fla., firm, and O'Brien Specialty Company of Syracuse, N. Y., to handle sales for Bulkley, Dunton equipment.

The company also named Rawson & Company of Houston, Henry P. Thompson Company, a Cincinnati firm, and R. R. Rothrock of New Orleans, as representatives for its equipment.

The Houston firm will service all industries in the Texas Gulf Coast area. Rothrock will call on all general industry in Louisiana, and the Thompson company will cover all industry, except paper in Southern Ohio.

The Middleton company will service industry in Southern Florida, while the firm in Syracuse will cover all industry in the up-state New York area.

Paul-Condit Opens Louisiana Office

Paul-Condit Company has opened a new office at Baton Rouge, La., to service the Louisiana area. John Kinsel was placed in charge.

Another recent appointment is W. L. Hendricksen, formerly associated with The Lummus Company, assigned to Paul-Condit's Houston office as a representative for the Houston and East Texas area.

Son Succeeds Father As Head of Company

Robert S. Thompson has been elected to succeed his father, Charles T. Thompson, as president of Thompson-Hayward Chemical Company. Both are members of the board.

Other officers recently elected: Fred M.

Designers

• PIPING
• STRUCTURAL

To design new oil refineries and chemical plants. Please send your resume to our Personnel Department. Your letter will receive immediate and confidential attention.

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Corrosioneering News

Quick facts about the services and equipment Pfaudler offers to help you reduce corrosion and processing cost.

Published by The Pfaudler Co., Rochester, N.Y.

Pfaudler takes the guesswork out of buying columns

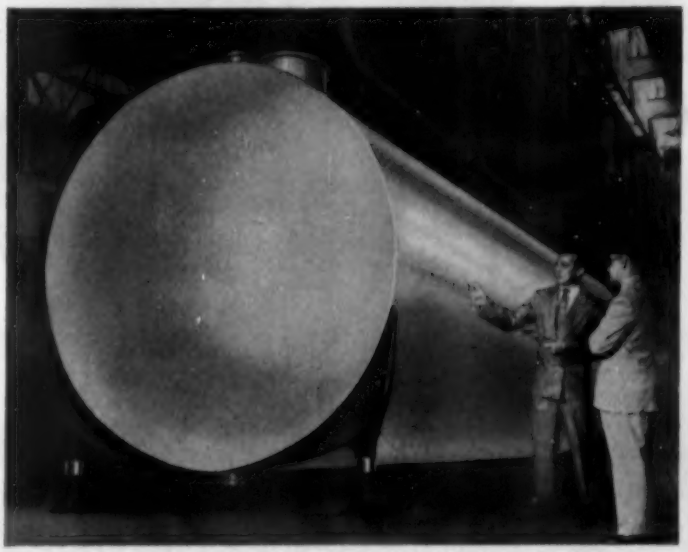
One of the knottiest problems in chemical equipment today is purchasing a column.

You may want one for distilling, absorption, extraction, spray drying or special reaction. You find yourself confronted with a bewildering selection of tray-type, bubble cap, Turbogrid, perforated, etc.; packed types or spray columns.

For help in selecting a column best suited for your particular problem, you get unbiased advice from Pfaudler, which offers *all* types in practically every material of construction, from low-cost, corrosion-resistant glassed steel to the expensive alloys.

You can save money with Pfaudler's "flexible standards." Most commonly requested "custom" features have been included in these stock designs, eliminating the expense of special design and fabrication, giving you faster delivery, and the advantages of standard components.

One of our process engineers, W. F. Swanton, has written an evaluation of various types of columns, called "How to Buy a Column." Write for your free copy of this helpful guide.



Latest news in chemical storage is new line of glassed steel "Chemstor" tanks—sizes up to 35,000 gal., low in cost with choice of two types of glass.

Durable new "Chemstor" tanks save money on chemical storage

One of the critical needs of the chemical processing industries is for a chemical storage tank that is easy to clean, prevents product contamination, and doesn't cost too much.

Now you have it in the new "Chemstor" series—unjacketed, horizontal, glassed steel tanks in standard sizes from 750 to 35,000 gals.

Two types of glass are available, depending on service requirements. Type No. 27 is for mild service, such as storage of phenol, formaldehyde, food products, and other noncorrosives. "Chemstor" tanks with this glass are available up to 35,000 gals.

For storing corrosive acids, such as sulfuric and hydrochloric, we recommend No. 28T glass. This provides excellent corrosion resistance, up to 125° F., and is available in the "Chemstor" line up to 15,000 gals.

Low first cost

"Chemstor" tanks cost you little—as low as 25¢ per gallon volume in the largest size. Both glass and steel are low-cost materials, the manufacturing method is not expensive, the tanks are simple in design—and built as standard models which can be produced quickly.

For low-cost storage, with product protection and fast cleaning, it will pay you to learn more about "Chemstor." Write for your free copy of Bulletin 918, giving full details.

How to save money on heat exchangers

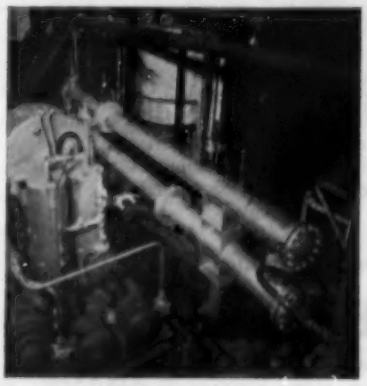
Would you like to side-step the extra expense of custom built equipment?

We've taken design features previously associated only with custom built heat exchangers and standardized them.

For a given heat transfer area, you may select the most applicable combination of length and diameter. Further, nozzles can be of any size and in any position and can be either threaded or flanged. This flexible standards program applies to fixed tube sheet, single or multipass, tube and/or shell side stainless steel units in diameters up to 30". This reduces over-all cost and speeds up delivery.

Another important development is the combination heat exchanger developed by Pfaudler, using costly alloys where the process demands it, but reducing the cost by using glassed steel wherever practical, such as in the bonnet.

Perhaps one of these Pfaudler designs can save you money, give you better results on *your* problem. Or perhaps special design work is required. Check with your Pfaudler representative for helpful advice.

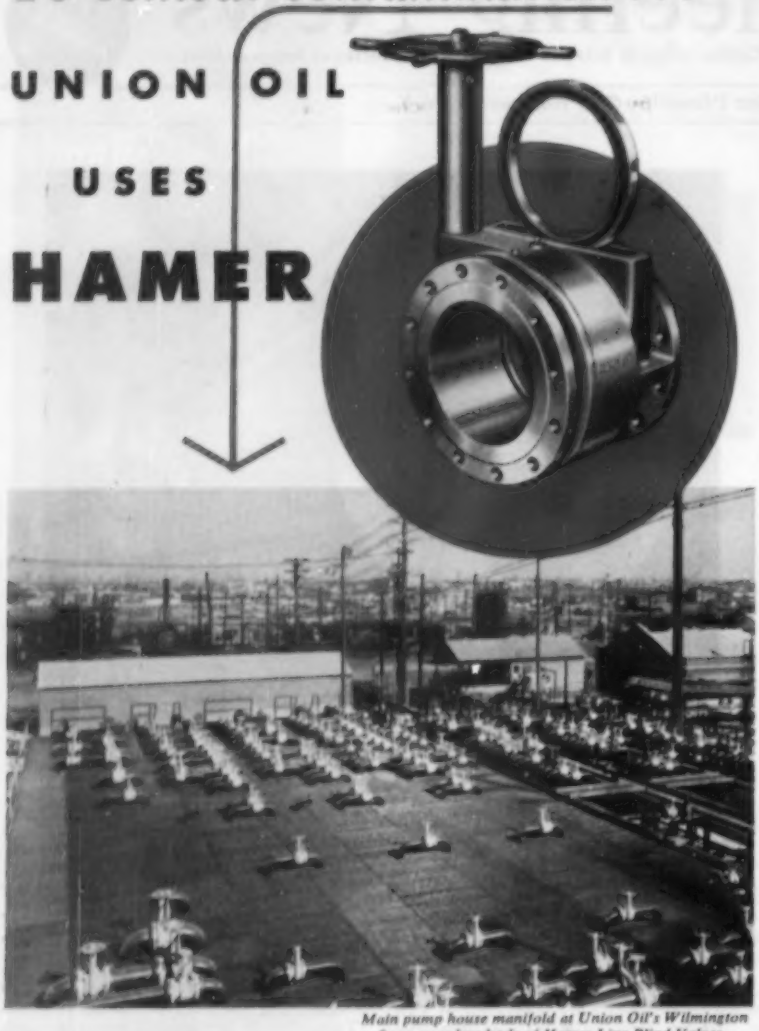


MONEY-SAVING TIP: Emphasize length rather than diameter, when buying heat exchanger, as shown in this installation.

For more data on advertised products, use Readers' Service Cards, last page.

To combat contamination . . .

UNION OIL USES HAMER



Main pump house manifold at Union Oil's Wilmington refinery uses hundreds of Hamer Line Blind Valves.

HAMER *Visible Shut-off* LINE BLIND VALVES

HAMER *Plug Valves*

Custom-crafted, Hamer Plugs welcome the tough applications where ordinary plug valves fall short. Standard dimensions. Readily installed.

With literally hundreds of different hydrocarbons moving through the refinery, Union Oil can't possibly risk product contamination. That's why they use Hamer Line Blinds. Hamer Line Blind Valves not only provide a permanent, positive leakproof shut-off, but are unsurpassed for long service-life and lasting safety. In addition Hamer Line Blinds are fast, simple to operate. One man can open or blind a line in one minute. Costly down time is reduced. Operational efficiency is vastly increased.

Send for FREE Catalog

HAMER VALVES, INC.

2919 Gardenia Ave., Long Beach 6, Calif.

Representatives throughout the World

Suppliers . . .

Goodwin, executive vice president and general manager; Lindley S. DeAtley, J. Frank Cavanaugh and K. A. Frambach, all vice presidents; J. Noland Franz, treasurer; R. E. Ballinger, secretary, and Carroll McCue, controller.

Also, C. O. Davis was named as vice president and general manager in charge of the company's Carman division, and Robert O. Lees received an assignment as vice president and sales manager for the division.

Bellco Engineering Names Assistant Chief Engineer

Wolcott

Eldon N. Wolcott, formerly with Foster-Wheeler Company, has joined Bellco Industrial Engineering Company as an assistant chief engineer.

During the seven years Wolcott served with Foster-Wheeler, he was assigned to project engineering and construction in Houston, New York and South America.

Retired Admiral Joins American Locomotive

Read Admiral Wilson D. Leggett, chief of the Navy's Bureau of Ships, has been elected vice president of American Locomotive Company. The appointment became effective upon his retirement from the Navy March 31.

Admiral Leggett reported for duty in the Bureau of Ships as deputy chief in 1951 and had served as chief since August, 1953. Under his leadership, nuclear propulsion for ships became a reality with the completion of the Navy's first atomic submarine. Also during his tenure, the Bureau began the construction of the Forrestal class of aircraft carriers.

Food Machinery & Chemical Merges with Chiksan

Food Machinery & Chemical Corporation has entered an agreement with Chiksan Company to exchange one share of Food Machinery and Chemical common stock for 2.30 shares of Chiksan common.

Chiksan, which has 260,264 shares outstanding, is a manufacturer of specialized pressure-type swivel joints and wing nut unions. Present operations include the main plant at Brea, Calif., and the Well Equipment Manufacturing Corporation at Houston.

New operations will function under the present management as the Chiksan division of Food Machinery & Chemical.

Representatives Picked

Frontier Engineering Services Company will represent Graver Water Conditioning Company in the western states. The Salt Lake City firm will cover northern and western parts of Wyoming, most of Nevada and all of Utah.

Koppers Opens New Office

Robert R. Bench has been named sales representative for a new sales office opened in Houston by the Chemical division of Koppers Company, Inc.

The Houston office will be under the

J&L PIPE J&L STEEL

J & L STOCKS SEAMLESS LINE PIPE IN REFINERY AREAS

A.S.T.M. A-53 A.S.T.M. A-106

J&L PIPE J&L STEEL

PESA PARTNERS IN PETROLEUM PROGRESS

Jones & Laughlin STEEL CORPORATION

SUPPLY DIVISION — TULSA OKLAHOMA

Serving The United States and Canada

For more data on advertised products, use Readers' Service Cards, last page.

Control Temperatures

within a

Fraction of a Degree

That's close enough for the most critical control requirements. Actual performance demonstrates that it is being done with a simple electrical unit—automatically. No attention is needed, the operator simply selects the control point on the controller.

A Gordon XACTLINE in the control circuit actuates the control before the set temperature is reached (up or down). The short on-off cycle (as short as three seconds) thus produced will give extremely close control. Because it's electrical—with no dependence on gears, cams, shafts, etc.—it is accurate and reliable.

For Any Heat Process

Gordon XACTLINE can be placed in the control circuit of any fuel-fired or electrically heated oven, furnace, kiln, injection molding machine, etc. Once installed, no adjustment or coordination with the control instrument is required regardless of size of furnace, length of heating cycle, or density of load. It can be used equally well with any existing indicating or recording standard pyrometer controller, regardless of age.

Gordon XACTLINE—a complete, factory-assembled, factory-adjusted instrument enclosed in dustproof case, ready for installation anywhere.

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Thermocouple Supplies • Industrial Furnaces & Ovens
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2019 Hamilton Avenue, Cleveland 14, Ohio

Suppliers . . .

supervision of the headquarters for Southern sales in Atlanta, Ga. Bench, formerly a sales-planning engineer, will be responsible for plastics, chemicals and adhesive sales in Texas, Louisiana, Arkansas and Oklahoma.

Stauffer Names Manager For Eastern Industrial Sales

Charles Loring has been appointed eastern district sales manager of the industrial chemicals division of Stauffer Chemical Company. He will be in charge of industrial sales in the New England, Central Atlantic and Southeastern states.

Loring

Loring, who has been in the company's sales group for 10 years, will be replaced by Gifford A. Acker, a member of the sales staff since 1940.

New Mexico Representative Appointed for Wolverine

Walter H. Olin has been selected as sales representative for W. G. Cline & Company, manufacturer's representative in the Rocky Mountain area for Wolverine Tube, division of Calumet & Hecla, Inc.

He will headquarter in Albuquerque, N. M., where he formerly was sales manager for a lumber company. He will service customers in New Mexico and West Texas.

Enterprise Company Grants Franchise to Turkish Firm

Ali Kefeli, owner of an Istanbul supply company, has been granted the Turkish franchise to distribute all products of Enterprise Engine & Machinery Company, a subsidiary of General Metals Corporation.

Kefeli

A native of Istanbul, Kefeli was educated in Paris and received bachelor of arts and mechanical engineering degrees at Stanford University. His firm will concentrate on municipal, industrial and marine markets in its sales of engines and process machinery.

Allis-Chalmers Assigns Representative to Houston

Robert A. Reynolds has been assigned to the Houston office of Allis-Chalmers' General Machinery division as a sales representative. He was an application engineer in the rectifier sales group at the company's West Allis works before he was recalled to military service in 1951. He recently was discharged.

Engineer Joins Inco

Vernon C. Robinson has joined the Development and Research division of The International Nickel Company, Inc., as a

FOR REPLACEMENTS UNDER HIGH PRESSURE

GAGE GLASSES

MAGNIFYING RED LINE

MASTER STANDARD RED LINE & CLEAR
Up to 500 lbs.

MASTER CLEAR & RED LINE EXTRA STRONG
Up to 600 lbs.

Made in Lengths up to 144" Long
And Outside Diameters ⅜", ½", ⅝", ¾", ⅞", 1", 1¼", 1½".

High Pressure Composition

ERNST RUBBER GASKETS

All sizes to fit your gages and valves

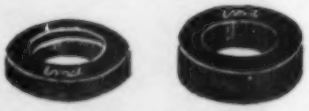

FIG. 21—Lip Mold FIG. 22—Standard

ERNST WATER COLUMN & GAGE CO.

Send for Catalog LIVINGSTON, N. J.

REPAIR LEAKS

QUICKLY—PERMANENTLY

SKINNER-SEAL PIPE JOINT CLAMPS stop leaks at joints. Put on under pressure—without interruption of service. Quick, simple, lasting repair. Sizes 1/2" to 24" incl. in stock.

SKINNER-SEAL COLLAR LEAK CLAMP—designed to stop every type of collar leak in oil and gas lines. Sizes: 2" to 13" inclusive.

M. B. SKINNER COMPANY

SOUTH BEND 21, INDIANA, U. S. A.

EAGLE-PICHER

SUPER "66"

INSULATING CEMENT

→ *STICKS* to hot or cold surfaces ←

BECAUSE IT STICKS, *it saves time*! Eagle-Picher Super "66" *really sticks,* makes difficult jobs easy, usually requires no reinforcing on applications up to 1½ inches thick. It applies quickly to any equipment, cold or heated up to 1800 F.

BECAUSE IT STICKS, *it saves money*! Low-cost Super "66" provides far greater coverage and more effective insulation. Its "springy ball" structure of small, resilient pellets of mineral wool, with thousands of dead air cells, assures maximum fuel savings!

BECAUSE IT STICKS, Eagle-Picher Super "66" can be used on irregular shapes where application of other insulations is often impossible.

PREVENTS RUST, TOO! Super "66" contains a special rust inhibitive that actually prevents corrosion.

WRITE FOR FREE SAMPLE TODAY!

Prove to yourself how easy it is to apply Super "66" wherever insulation is needed!

Since 1843

EAGLE EP PICHER

THE EAGLE-PICHER COMPANY

Producing a complete line of industrial insulations

Cincinnati 1, Ohio

(Member of Industrial Mineral Fiber Institute)

(Conforms to Commercial Standard CS117)

For more data on advertised products, use Readers' Service Cards, last page.

Suppliers . . .

member of the Twin Cities Technical Field section. Before his present appointment, Robinson was associated with Norma-Hoffman Bearing Corporation as a field engineer.

Named District Engineer

Robert J. Prudhomme has been appointed district engineer for compressor and engine sales for the Oil Well Supply division of U. S. Steel Corporation at Dallas. Formerly assistant district engineer at Dallas, Prudhomme has four years' experience in sales and engineering before he joined the Oilwell organization in 1952.

Tube Turns Names Head For New Sales Division

Jack D. Tolliver has been made manager of the recently-established Sales Development division of Tube Turns. He formerly was assistant manager of the Engineering Service division.

Tolliver

Tolliver joined Tube Turns as an engineering-sales trainee in 1949. He was assigned to the Engineering Service division in 1950 and was named as its assistant manager in 1954.

TENNESSEE'S

SO_2

LIQUID SULFUR DIOXIDE

The Highly Efficient, Inexpensive SOLVENT!

Liquid Sulfur Dioxide is particularly suitable as a solvent for recovery of aromatics. It is completely miscible with aromatic hydrocarbons over a very wide temperature range, while the solubility of naphthene and paraffin hydrocarbons is limited and decreases with decreasing temperature. Recovery of a higher percentage of aromatics is obtained for hydrocarbons over a wide boiling range.

Tennessee's highest quality Liquid Sulfur Dioxide can be effectively and economically applied to your operation. We would welcome the opportunity of discussing this with you.

SULFUR-DIOXIDE HIGHEST QUALITY SO_2

CONTAINERS: Cylinders, Ton Drums, Tank Trucks and Tank Cars.

TENNESSEE CORPORATION

617-629 Grant Building, Atlanta, Ga.

Allied Chemical & Dry Ups Formaldehyde Concentration

Higher concentration formaldehyde is being produced by Nitrogen Division, Allied Chemical & Dry Corporation, at new facilities recently placed in operation at its South Point, Ohio, plant.

The new facilities, utilizing a process developed in company laboratories, can produce formaldehyde in concentrations up to 50 percent. Formaldehyde previously was made at South Point in concentrations of 37 to 45 percent.

American Cyanamid Picks Technical Representative

R. G. Keppler was appointed technical sales representative for the Refinery Chemicals department of American Cyanamid Company.

Keppler joined Cyanamid's Refinery Chemicals department in 1953 as a senior technical representative and coordinator. Previously, he served Standard Oil and Ultra-Pennsylvania Refining companies in a similar capacity.

Wolverine Tube Names Chicago Sales Representative

Mel Jackson has been appointed sales representative for Wolverine Tube, Division of Calumet & Hecla, Inc. He will cover the northwestern part or Indiana and the south side of Chicago and the immediate suburbs.

Jackson

Formerly vice president in charge of sales for Grant Wilson, Inc., Jackson will headquarter at Wolverine's Chicago office, where he will work under E. J. Campbell, midwestern district sales manager.

Lukens Steel Launches Market Expansion Program

Lukens Steel Company, launching a five-year expansion of its current markets, will intensify product development to include diversification outside the capital goods field. The company will begin manufacturing and marketing end products and enter new markets.

Market studies by the company indicate a 20-percent increase in the use of steel plant in the construction industry during the next five years, an increase of 18 percent in the electrical equipment industry, and a 30 percent increase in the industrial-machinery and process-equipment industry.

Worthington Supplies Turbines for Shell Refinery

Worthington Corporation will supply four turbines to Shell Oil Company for its refinery at Anacortes, Washington. The turbines will be used to drive centrifugal compressors for a fluid catalytic cracking plant.

Houdry Catalyst Supplies To be Made in Europe

Houdriforming process licensees in Europe will be able to obtain catalyst supplies made on the continent. An agreement has been signed with Chemische Werke Huels A. G., at Marl, Kreis Recklinghausen,

Harbison-Walker castable refractories do many refinery jobs *most satisfactorily*

The many refractory requirements for the diversified refinery units are fulfilled most advantageously by Harbison-Walker Castables especially adapted for each particular purpose.

The excellent service resulting from the use of the various classes of Harbison-Walker Castable Refractories is due to their desirable properties, such as volume stability and strength over a wide temperature range, low permeabilities and thermal conductivities, and their high resistance to abrasion and chemical attack.

The brief descriptions of the brands of Harbison-Walker Refractory Castables principally used for refinery service, at the right, serve to illustrate their outstanding properties.

HARBISON-WALKER CASTABLES

H-W EXTRA STRENGTH CASTABLE—Strongest of the refractory castables—it has exceptional strength and resistance to erosion over the range of temperatures up to its service limit of 2400° F.

H-W 56 LIGHTWEIGHT CASTABLE—Possesses good mechanical strength, light weight and unusually high insulating value.

H-W HIGH-ALUMINA CASTABLE—A highly refractory castable having a service limit of 3000° F. Suitable for use at extremely high temperatures.

H-W CHROME CASTABLE—A superior chrome ore base monolithic refractory which, because of its composition, is most resistant to various fluxes at high temperatures.

These and other HARBISON-WALKER PRODUCTS will be shown at the INTERNATIONAL OIL EXPOSITION in Houston, Texas, MAY 3-8 in Booth No. 238

HARBISON-WALKER REFRACTORIES COMPANY
AND SUBSIDIARIES *General Offices: Pittsburgh 22, Pennsylvania*
WORLD'S LARGEST PRODUCER OF REFRACTORIES

For more data on advertised products, use Readers' Service Cards, last page.

Sure, we sell HOLES but our
STRAINERS & FILTERS
ARE MADE OF REAL QUALITY MATERIALS
BY MASTER CRAFTSMEN
THAT'S OUR BUSINESS

COMPLETE SELECTION OF WEAVES, SIZES, METALS

For long life and accuracy—Specify "Cleveland." We fabricate strainer and filter screens to individual job requirements. Quantities: One to One Million in all commercial metals and alloys. We have the equipment, facilities, and experience to better serve your needs for strainer and filter elements.

WRITE FOR BULLETIN No. 7

THE CLEVELAND WIRE CLOTH & MFG. CO.
3573 E. 79th STREET - CLEVELAND 5, OHIO

The Chemistry of Petrochemical Reactions

By LEWIS F. HATCH, Ph.D.
Professor of Chemistry
University of Texas

This 192-page, completely indexed volume is the only thorough and exhaustive treatise on the basic chemistry of reactions and processing of those products and intermediates popularly classified as petrochemicals.

A completely contemporary study, this book is an immediate and valuable reference for anyone engaged in either the chemical or refining industry.

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Suppliers . . .

Germany, under which the Huels plant will produce catalyst for use of Houdry licensees in Europe.

Houdriforming catalyst manufactured by Huels, under the agreement, may be sold also to other refineries under licensing arrangements with Houdry. Up to now, the only source of Houdriforming catalyst had been the Houdry plant at Paulsboro, New Jersey.

Stauffer Picks Assistant For Insecticide Plants

A. M. Powell has been named assistant production manager in charge of eastern sulphur and insecticide plants for Stauffer Chemical Company.

Powell will headquarter at Chauncey, N. Y., and will be responsible for Stauffer agricultural production facilities in New Jersey, Missouri, Arkansas, Texas, Louisiana, and Florida.

Company Changes—

J. N. Rogers, formerly office manager of the Chicago sales office of the Tubular Products division of **The Babcock & Wilcox Company**, has been appointed as a district salesman assigned to the company's office in St. Louis, Mo. . . . **Ernest K. Hunt** has been appointed as public relations manager for **American Cyanamid Company.** He formerly was advertising manager for the company's Organic Chemicals and Pigments division . . . **Harry M. Pier**, who served as general sales manager of **Research-Cottrell, Inc.**, has been selected as a special assistant to the chairman of the board to study atmospheric pollution . . . **Richard L. Erlin**, formerly associated with Louis Berkman Company as vice president in charge of sales, has joined **Kaiser Steel Corporation** as manager of engineering sales.

S. G. Paddock, manager of **Burgess-Manning Company's** Dallas division, has been elected vice president. He also is a sales director for the company . . . **R. G. Keppler** has been chosen as technical sales representative for **American Cyanamid Company's** Refinery Chemicals department. Keppler, who was a senior technical representative and coordinator for the company, will be located in Houston . . . **Eugene R. Hoff** has been promoted from warehouse sales manager to New York district sales manager for **Laclede-Christy Company**, a division of H. K. Porter Company, Inc. . . . **Evan R. Rotner**, formerly associated with **Stauffer Chemical Company** at its carbon disulphide research center in Chauncey, N. Y., has joined the research and development staff of **Pall Filtration Companies** in Glen Cove, N. Y.

David A. Stevenson has been appointed to head **Mason-Neilan Regulator Company's** new district office in San Francisco. He formerly was sales engineer at the company's Los Angeles office . . . **Martin F. Wilkerson** is the new manager of **Diamond Alkali Company's** branch sales office in Houston. Transferred from Memphis, Tenn., where he was a member of the company's sales staff, Wilkerson replaces **John W. Kennady**, named general manager of Diamond Black Leaf Company.

Rainey Elliott has been elected president of the Supply division of **Jones & Laughlin Steel Corporation.** Elliott, general manager of the division, had been

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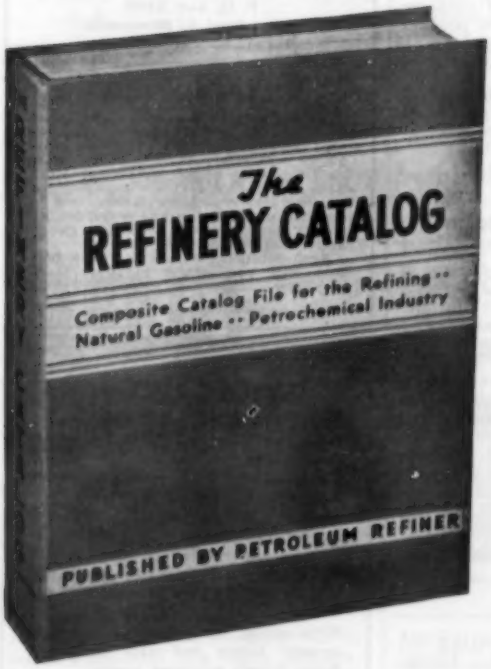
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vice president and director of J&L Supply Company before it was incorporated into the steel organization in 1952 . . . **J. P. Murphy** and **R. E. TenHoor** received new appointments with the creation of a new Technical Service & Development section of **The Dow Chemical Company.** Murphy has been transferred from the company's sales office in Chicago to the new section's sales development unit at Midland, Mich. TenHoor, with Technical Service and Development since 1953, was named supervisor of the new industrial chemicals section.

New President Elected For Separator Company

O. Muller-Habig has been elected president of Centrico, Inc., U. S. distributor for Westfalia Separator A. G. He succeeds his brother-in-law, Heinz W. Habig, who died last summer in an air crash.

Muller-Habig

Muller-Habig is a director of Westfalia Separator, a West German manufacturer of centrifugal separators. For many years, he has been business manager for the German company in Oelde.

Celanese Corporation Fills New Manager's Position

L. P. Wenzell has been transferred from the Development department of Celanese Corporation of America to a new position as manager of industrial developments in the Market Development department of the company's Textile division.

Before joining Celanese in 1953, Wenzell had been with the U. S. Bureau of Mines, Kolker Chemical Works and Monsanto Chemical Company.

Van der Horst Appoints Assistant Research Director

Dr. Hyman Chessin has been appointed as assistant director of research and development for Van der Horst Corporation.

Chessin

Prior to joining Van der Horst, Dr. Chessin taught at Kenyon College and conducted research at the University of Arkansas. He received his doctor's degree in physical and electrochemistry at Western Reserve University in Cleveland.

Minneapolis-Honeywell Trains 315 During 1954

Some 315 employes representing 204 companies in 33 states and nine foreign countries were graduated from Minneapolis-Honeywell Regulator Company's Industrial Division Training School in Philadelphia in 1954.

Courses covered instruction in the application of electric, pneumatic and electronic automatic recording, measuring and controlling instruments, including repair and maintenance. The courses lasted from two to six weeks.

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Man with Chemical Engineering degree or equivalent, to assist Process Superintendent in operation of new independent refinery. Must have several years' operating experience including working knowledge of modern instrumentation and process controls.

Duties will include technical assistance, some operating supervision, scheduling, and coordination of closely integrated units.

Please send complete resume, including salary requirements to:

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Major operator of gasoline plants has staff opening for qualified process, design and construction engineer. Requires supervisory experience and ability to direct major programs. Must have engineering degree with minimum of ten years experience in the field of gasoline plant design and construction. Salary commensurate with experience and qualifications. Age limit 40.

Send detailed personal and work history with photograph to Box 194-R, c/o Petroleum Refiner, Houston, Texas.

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Graduates with minimum 3 years' process design experience in oil refinery or surface oil producing facilities. For New York office. Must, however, be willing to relocate in foreign operation at some future date.

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Write giving full particulars regarding personal history and work experience. Please include telephone number.

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6—I-R KVG-6 gas engine compressors, 600 & 660 hp complete with accessories

$50,000 new spare parts

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3—100# vessels, 10′ x 20′, 6′ x 20′, 8′ x 16′

6—Centrifugal pumps, 2000 GPM, 90′ hd; 400 GPM, 290′ hd; 60 GPM, 460′ hd.

6—M. W. Kellogg 2400 sq. ft. ADM heat exchangers

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6′ x 58′, Chrm. lin. tower, 20 tray, 50#, mfgd. '51

6′-6″ x 55′; 6′ x 27′; 5′ x 27′; 0′-42″ x 49′; 0′-30″ x 35′ steel towers

5—ADM heat exchangers, 1600, 500 sq. ft.

2—800 sq. ft., 675# 800° F heat exchangers

5′ x 40′ Chrm. lin. 90# vessel

4′ x 40′ 325# vessel

BJ 5 stage NiCh 400 GPM, 2000′ hd steel & chrome pipe, valves, fittings and many other items

Equipment Elsewhere

7′ x 26′—SS, 10 tray, 50#

7′-6″ x 56′, 30 tray, 45#

2′ x 60′, 560#

5—300# vessels, 8′ x 30′, 7′ x 30′

2—Pacific 6 stg., 730 GPM, 2000′ hd

3—Clark engines, RA-8-MA-4

10—Steel heat exchangers, 1500, 360, 260 sq. ft.

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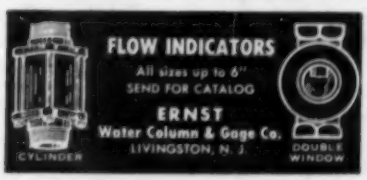

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• Additional equipment lines for industrial and power plant use wanted by manufacturers' representative for eastern half of Pennsylvania, southern half of New Jersey, and state of Delaware. Box 192-R c/o Petroleum Refiner, Houston, Texas.

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Beautiful, square shaped, 616 acres, gently rolling, Blue Grass farm, located in racehorse country, 5 miles from Paris, Kentucky, and 18 miles from Lexington, Kentucky, the heart of the famous Blue Grass section.

Fronts on a main thoroughfare (US 227), bounded on two other sides by a black top county road. Year round water supply from Green Creek, running through middle of farm, fed by several never failing springs.

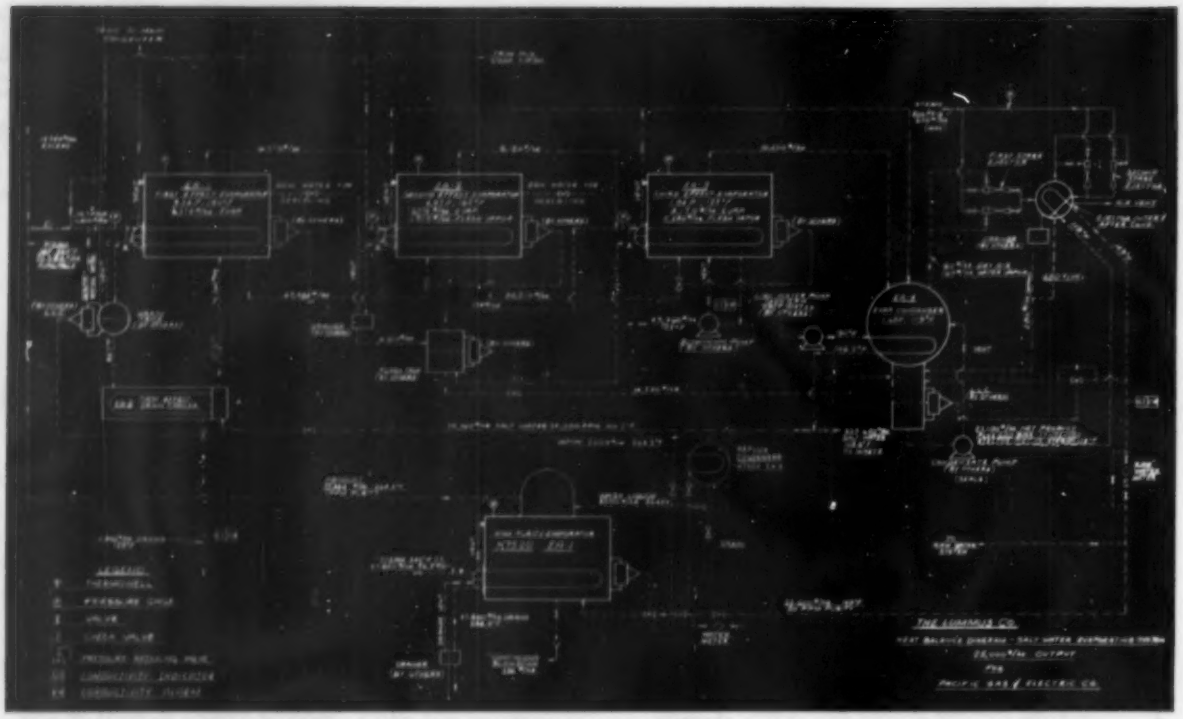
Rich, fertile, soil, very high in phosphate from underlying phosphoric limestone, producing excellent Burley tobacco. 1954 base of 21.5 acres. Ideal farm for all livestock—especially racehorses.

For further information contact owner, James C. Stone, Jr., either directly or through an agent, at 1218 Heyburn Building, Louisville 2, Kentucky. Telephone Clay 6336.

HELP WANTED

Sales Opportunity

Well known Southwestern business firm needs a chemical engineer with refining background for sales position. If you are 25 to 40, have the desire to sell, are intelligent and willing to work hard, this job offers real money-making opportunity. In your reply, please give your complete education and business history, whether or not you would be willing to relocate. Address Box 190-R Petroleum REFINER.



THIS EVAPORATOR SYSTEM CONVERTS THE SEA INTO PURE WATER

The Lummus Company, working closely with Pacific Gas & Electric Co. and Bechtel Corporation, has designed and built a system consisting of triple effect evaporators and high purity bubble tray evaporators, one set for each of two boilers.

Each evaporator system will produce 50 gallons per minute of fresh water at design conditions having a vapor purity of less than 1 ppm total dissolved solids, from sea water containing approximately 36,000 ppm dissolved solids.

The ocean water first enters the evaporator condenser and then goes to the first effect drain cooler where it is heated to 150°F. before entering the first effect evaporator shell. From the first effect evaporator shell, the ocean water cascades to the second and third effect evaporator shells at which point its concentration would be one and one-half times that of the entering ocean water.

The vapor from the first and second effect shells is used as the heating medium for the second and third effect shells. Steam from the fourth bleed point of the turbine is used as the heating medium for the high purity evaporator, and part of the vapor from the high purity evaporator is used as the heating medium for the first effect evaporator. The excess vapor produced in the high purity evaporator is bled to the main condenser.

Lummus engineers will be pleased to work with you on your next project.

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What's New In Equipment . . .

High Viscosity Your Mixing Problem?

Here is a solution . . .

A unique portable type mixer called Shear-Flow is now being produced by Gabb Special Products, a division of the E. Horton & Son Company. Originally developed for mixing the more viscous types of textile inks, this new mixer should have many applications in the refining, natural gasoline and petrochemical industry in the dispersion of solids in liquids, and in mixing any liquids where high viscosity is a problem.

The Shear-Flow Industrial Mixer consists of two impellers and a stator spaced closely together. The two impellers turn in opposite directions and create a pumping action which moves the material from the bottom upward through the veins of the stator. Because the impellers turn in opposite directions with a very small space between, a shearing action takes place which breaks up and disperses any particles which are present. The schematic diagrams illustrate the basic principle of this mixer.

Some of the features of this new mixer are:

- Lower over-all maintenance cost.
- Low RPM with high speed results.
- Ease of cleaning.
- Creates no vortex.

The manufacturer would welcome the opportunity to mix sample batches of material sent in from any processor desirous of improving present mixing methods. For complete details, simply . . .

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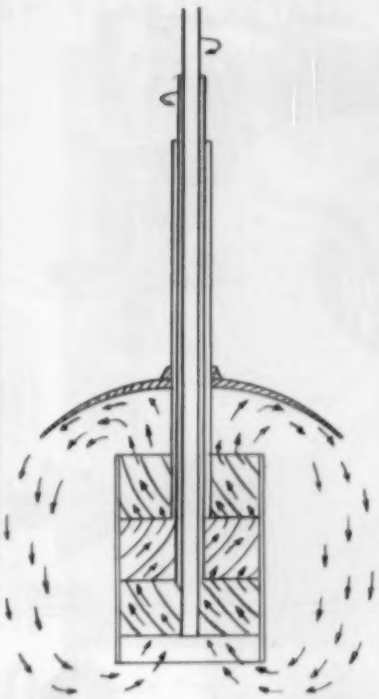

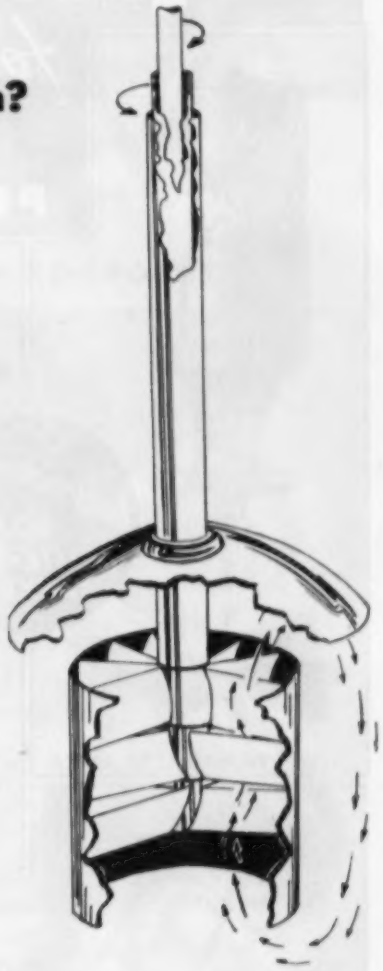

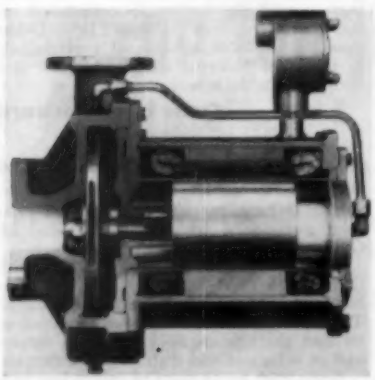

A small seal-less centrifugal pump for high heads is the latest addition to the Chempump line of leakproof "Canned-Rotor" pumps. Guaranteed not to leak, the new 1½ horsepower pumps give heads to 150 feet at capacities up to 53 gpm.

Offered in cast iron, 316 stainless steel, Monel or Carpenter-20, these seal-less centrifugals, as seen in the illustration, combine pump and motor in a single compact unit. In operation, the pump fluid is allowed to circulate through the rotor chamber of the motor, which is isolated from the stator parts by a stainless steel liner. The circulation serves to lubricate the bearings plus cooling the motor.

The new standard Model CFH Chempump handles corrosive, explosive and other "problem" fluids at temperatures up to 450°F. and pressures up to 300 psi.

For additional information on this new line of pumps, simply . . .

Circle E2 on Postcard

A multiple pressure readout system now makes it possible to measure up to 200 pressures at a given instant, and to readout digital values, accurate to 1 part in 2000, of all measured pressures within two minutes of the time the pressures were sensed. Such simultaneous measurement of pressures, with rapid information presentation—in a single package unit—should prove of great value to the operating and research personnel in the refining, natural gasoline and petrochemical industry. This packaged unit, the F & P Multiple Pressure Readout system was developed and is being marketed by the Fischer & Porter Company.

The system consists of a number of pressure comparators, each of which receives on the signal side of its diaphragm one of the pressures which must be sensed. The other side of each comparator is connected to a manifold common to all of the comparators, in which a pressure "sweep" is introduced. The simultaneous sensing feature of the unit is accomplished by having all signal pressures sealed in the comparators by electrically actuated solenoid valves at the beginning of the sensing cycle.

As the sweep pressure in the common manifold becomes equal to the various

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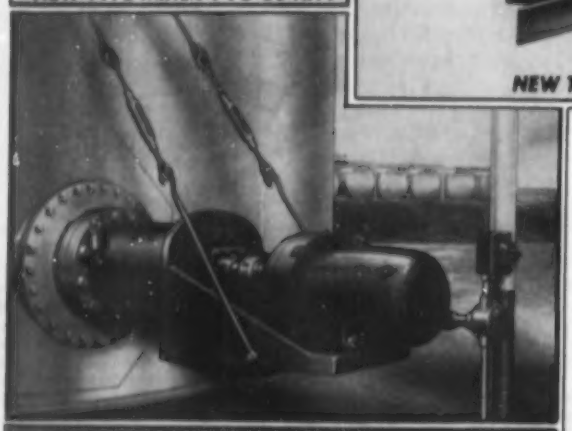

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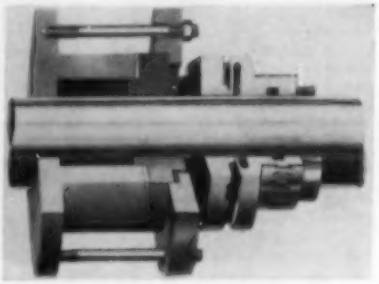
New Equipment . . .

pressures in the comparators, contacts are actuated in the comparators which cause their respective pressures to be individually "memorized" in an electrical memory system. At the conclusion of the sweep cycle, the readout cycle begins and the memory delivers the information sequentially to the automatic logger readout device.

The multiple pressure readout system is a fully enclosed, tested, and guaranteed unit, ready for connection to pneumatic inputs and power source. Further information is available now.

Circle E3 on Postcard



A chemically impervious mechanical seal has been announced by United States Gasket Company. This external rotating mechanical seal for pump, or agitator shafts has been designed to last longer and give superior service under a wide variety of difficult chemical service conditions. These units have been field-proven for three years of actual service in handling acid, alcohols, alkalies, hydrocarbons, abrasives and tarry materials.

The seal rotates with the shaft. The only bearing surface is between precision ground rotating and stationary faces. Extremely low friction load on shaft insures lower starting torque and power cost. The design of the seal makes use of a balanced bellows—the bellows being made of Teflon (Registered trade mark E. I. du Pont de Nemours & Company).

Named Chemiseal Mechanical Seal, these units are being manufactured in standard sizes from ⅞" to 2⅛". Other sizes are available for special applications. A technical bulletin describing this new seal is available now.

Circle E4 on Postcard

A nylon-reinforced oil discharge hose, 60% lighter in weight than conventional hose for the same service, has been announced by the B. F. Goodrich Company Industrial Products Division.

The new hose combines strength with light weight and flexibility to save valuable time and effort in handling. Called Type 950, it is recommended for loading oil and gasoline in dock and ship service and in refineries and distributing terminals.

From four to 14 plies of individual parallel nylon cords are imbedded in rubber and spiral the hose tube to form the carcass of the hose. This new hose is designed specifically to eliminate fatigue failure and hose "flutter."

Built for working pressures up to 150 psi, this hose is available in 3,4,6,8,10, and

Turbo-Topics

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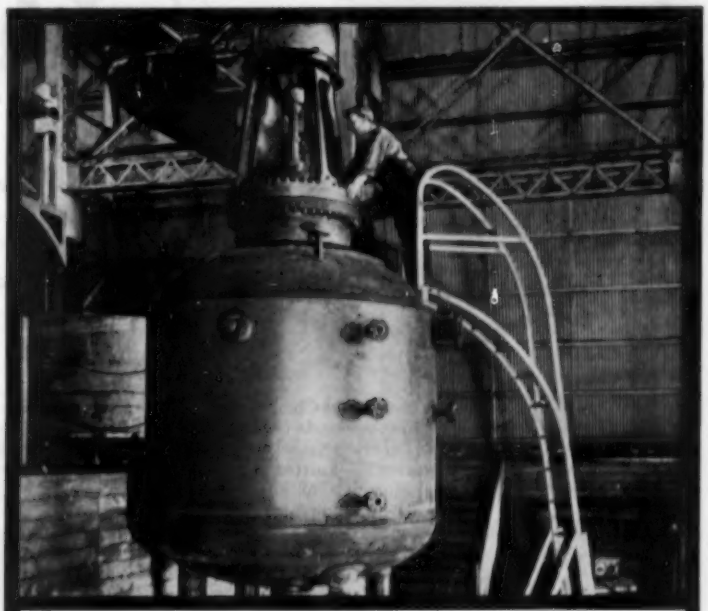

Turbo Contactor For Butane Isomerization: *furnished to C. F. Braun & Co., Engineers and Constructors as part of a plant built by them in 1942 for a West Coast petroleum processor.*

For over 25 years, Turbo has supplied leading oil companies with precision-built mixers for petroleum processing. In many plants, the original Turbos are still in operation—after more than 20 years of continuous 24-hour maintenance-free service. This outstanding service record is a testimonial to the rugged design built into each and every Turbo. If you have a process problem, call on Turbo. A Turbo engineer is always available to work with your engineers on request.

***How the petroleum industry uses Turbo-Mixers**—Asphalt filling, asphalt oxidation, asphalt cut back blending, spent doctor oxidizing, doctor treating, drilling mud mixing, lube blending, solvent extraction and many others.

Send for technical bulletins describing the use of Turbo-Mixers in the petroleum processing field.

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For more data on advertised products, use Readers' Service Cards, last page.

Increased feed capacity

Refineries and Chemical Plants can increase feed capacity of process vessels (including vacuum equipment) 30-35% with Yorkmesh Demisters. That's because Yorkmesh Demisters—knitted wire mesh separators—do an outstanding job of entrainment control. In any process vessel handling both liquid and vapor phase materials, these wire mesh demisters permit greatly increased throughput in new or existing equipment without carrying impurities and contaminants into the overhead product.

For increased feed capacity (higher vapor velocities with negligible pressure drop)—for improved overhead quality (entrainment separation efficiencies above 99.9%)—for increased efficiency all around, it will pay to investigate Yorkmesh Demisters.

Write for free copy of case studies #1001 and #1004 . . . for the complete story on Yorkmesh Demisters ask for Bulletin #16.

Fills the BILL . . .

1. Contaminated with fine liquid droplets the vapor rises through the tower.
2. As the vapor stream passes through the fine wire mesh, the droplets impinge on the wire surfaces, coalesce into large drops and fall off.
3. The vapor is now dry and free from impurities.

Yorkmesh Demisters provide clean separation between liquid and vapor in:

Vacuum towers • Distillation Equipment
Gas Absorbers • Scrubbers • Evaporators
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New Equipment . . .

12 inch sizes. Complete details are available now.

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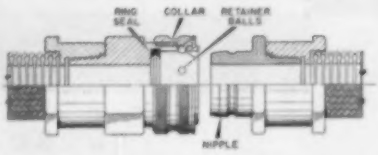


A unique hose coupling, designed to help provide low cost yet dependable piping for air and steam lines needed for cleaning processing vessels and their related pipings, is being produced by Titeflex, Inc.

One plant handling viscous sticky materials which may change from fluid to solid with a shift of a few degrees in temperature, must clean all processing equipment, blending tanks, and connecting pipe lines between batches to prevent contamination of the next batch. This plant has solved its problem by the use of a flexible hose, which can be connected to a steam or an air pipe by means of a quick connect coupling. This simple solution has eliminated the cost of a complex fixed piping manifold and the necessity of outdoor piping for air and steam supply and the attendant difficulties of the freezing of the steam condensate.

The Titeflex couplings, by a ball and groove arrangement, permit the hose to swivel fully in addition to providing a leakproof connection. These connections should have wide application in the refining, natural gasoline and petrochemical industry.

Complete technical information is available on Titeflex couplings now.

Circle E6 on Postcard

Volumetric load measuring elements, capable of a wide range of application have been announced by Taylor Instrument Companies. Rugged, dependable, and economical, the units directly measure tension, compression, or force, and indicate or record all measurements up to a maximum distance of 200 feet. Accuracy of the units, which averages 99 percent, is unaffected by friction or hysteresis in the loading system.

Since the newly designed elements do not come into contact with the material being weighed, they are of special interest to those in the refining, natural gasoline and petrochemical industry faced with the problem of weighing corrosive liquids or heavy solids.

Four types of elements, spool, ring, diaphragm, and capsular, are available.

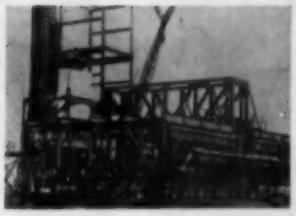
The spool type element is used on applications where loads are especially heavy and in need of constant checking—for example, on tank cars. Ranges for the spool type element are up to 250,000 pounds for compression loads, and up to 30,000 pounds for tension loads.

The other types of elements range as follows:

- Ring type—up to 25,000 pounds, compression only.
- Diaphragm type—up to 6,250 pounds.
- Capsular type—up to 300 pounds,

DOLLINGER DELIVERS #1

EXPORT STEEL FRAMING



Some 180 tons of Dollinger structural steel went into this oil heater framing at a South American refinery.

Dollinger accurately handled every intricate detail of fabrication, and expedited delivery to the dock to meet the shipping schedule. Foster Wheeler Company designed and erected the structure.

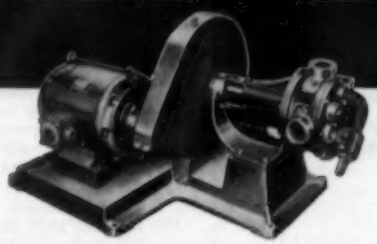
STEEL BY DOLLINGER

AROUND THE WORLD

For more than 50 years quality producers of structural steel and plate steel.

JOHN DOLLINGER, JR., INC.
BEAUMONT, TEXAS

There's a Viking Pump for every requirement



Viking Pumps are the outstanding pumps of the petroleum industry. Consider their versatility, longer life and greater operating economy for your particular needs. Our Southern Engine & Pump Company engineers will be pleased to help you select the right Viking for your job.

The gear drive unit above has gearing totally enclosed in a sheet metal guard. This and other Viking Units are available in a wide range of sizes and capacities. Write for new literature or engineering counsel.

Distributors

SOUTHERN ENGINE & PUMP COMPANY

MANUFACTURERS • MACHINERY FACTORS • CONTRACTORS

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STOP Corrosion with...

Van-Cor

PLASTIC PIPE, FITTINGS AND FABRICATIONS

★ *Both Chemically Resistant and Impact Resistant Types*

★ *Half the Weight of Aluminum, with High Tensile Strength*

★ *Readily Formed, Machined, Drawn, Molded or Welded*

AVAILABLE FORMS

SHEETS... 1/32" through 1". PIPE... 1/2" through 8" diameter (10 or 20 ft. lengths). ROUND BARS... 1/8" through 5" diameter (10 ft. lengths). WELDING ROD... 1/8" and 5/32" diameter.

TYPICAL APPLICATIONS

A rigid non-plasticized polyvinyl chloride, Van-Cor is fabricated into such products as: Ducts, Hoods, Chemical Tanks, Tank Liners, Plating Racks, Fume Stacks and Piping.

WRITE FOR ILLUSTRATED BULLETIN, SPECIFICATIONS, AND NAME OF NEAREST DISTRIBUTOR

INDUSTRIAL DIVISION OF
COLONIAL PLASTICS MFG. CO.

SUBSIDIARY OF THE VAN DORN IRON WORKS CO.
2685 EAST 79th STREET • CLEVELAND 4, OHIO

Patterson

STANDARD OF THE INDUSTRY

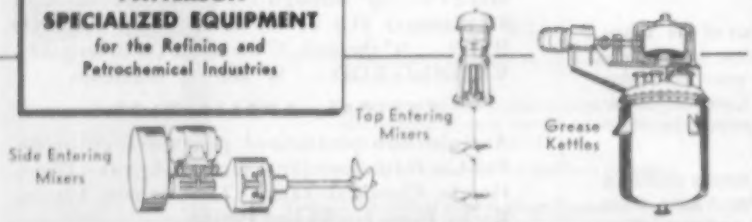
Grease Kettles

FOR PROFITABLE PRODUCT PROCESSING

The Patterson Grease Kettle is built in sizes to meet standard requirements for most economical batch processing of grease products. This equipment is used throughout the industry: let us give you the detailed reasons why!

Richard L. Carmody
President

PATTERSON SPECIALIZED EQUIPMENT
for the Refining and Petrochemical Industries



The Patterson Foundry and Machine Company
East Liverpool, Ohio, U. S. A.
NEW YORK, BOSTON, BALTIMORE, PHILADELPHIA, PITTSBURGH, DETROIT, CINCINNATI, ATLANTA, CHICAGO, ST. LOUIS, HOUSTON, DENVER, LOS ANGELES, SAN FRANCISCO, SEATTLE

The Patterson Foundry and Machine Company, (Canada) Limited
Toronto, Canada
MONTREAL

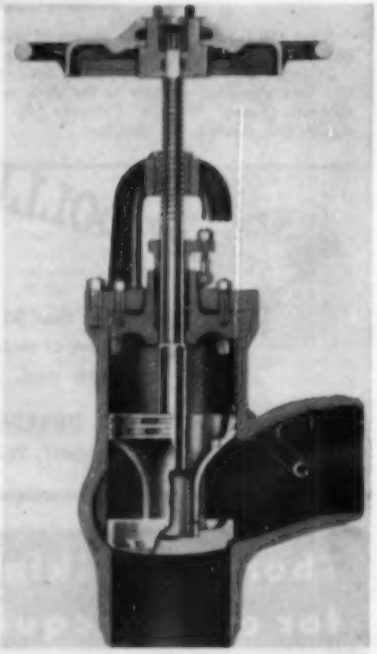
New Equipment . . .

and adjustable to a minimum span of 30 pounds.

Complete details are available on these new units now.

This item supplements Taylor Instrument Companies data on page 836, of The Refinery Catalog, 22nd Edition.

Circle E7 on Postcard



Internally streamlined valves have been announced by Edward Valves, Inc., a subsidiary of Rockwell Manufacturing Company. The streamlining feature which lessens wear and reduces pressure drop is featured in the new re-designed 600 lb. line of angle stop, check, and non-return cast steel valves.

Features formerly available in Edward 900 lb., 1500 lb., and 2500 lb., valves are now incorporated in the new 600 lb. valves to insure easier operation and cut down maintenance requirements. Included among these features are:

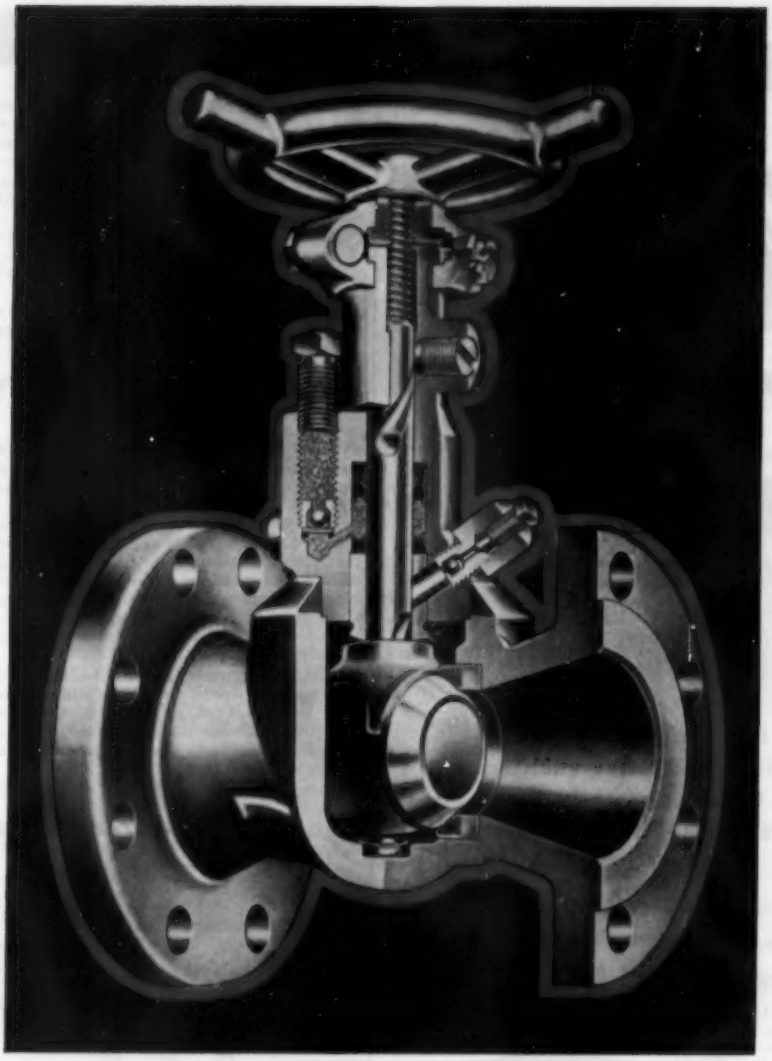
- Swivel disk construction.
- Stellite faced disks.
- Integral stellited seats.
- Improved pressure seal bonnet joint.

Additional information and complete technical details are available now.

Circle E8 on Postcard

An effective zeolite bypass is now being offered by Graver Water Conditioning Company. This system controls the proportionate mixing of untreated hard water and treated, fully-softened water to produce whatever degree of hardness is desired. It is being offered for those who find it necessary to treat water to a controlled degree of hardness rather than complete softness.

Operation is extremely simple. Only a



ORBIT VALVES®

ASA CLASS VENTURI TYPE

•

Flanged End Only

Carbon Trim
Stainless Trim

(MAXIMUM RATED WORKING TEMPERATURE 250° FAHR.)

The venturi is an addition to Orbit's line of ASA Class valves. We now offer both the full round opening type and the venturi opening type.

Packed with Teflon

Now being used in the following basic chemical process industries: Petrochemical industry, fertilizers, rubber, chemicals. Other applications include natural gas gathering and distributing systems. Hydrocarbon processing plants.

(and many other applications)

•

For complete description and prices see 22nd edition of Refinery Catalog or write for literature.

AVAILABLE SIZE RANGE — VENTURI TYPE
FLANGED END ONLY

ASA CLASS	SIZES	ASA CLASS	SIZES
150 Lb.	2", 2½", 3", 4"	900 Lb.	3", 4", 6"
300 Lb.	2", 2½", 3", 4", 6"	1500 Lb.	2½", 3", 4"
400 Lb.	4", 6"	2500 Lb.	2½", 3", 4"
600 Lb.	2", 2½", 3", 4", 6"		

AVAILABLE SIZE RANGE — FULL ROUND OPENING TYPE
FLANGED AND SCREW END

ASA CLASS	SIZES	ASA CLASS	SIZES
300 Lb.	2", 2½", 3", 4"	900 Lb.	1", 1½", 2", 2½", 3", 4"
400 Lb.	4"	1500 Lb.	1", 2", 2½", 3"
600 Lb.	1", 1½", 2", 2½", 3", 4"	2500 Lb.	1", 2", 2½", 3"

ORBIT VALVES®

There is Only One ORBIT VALVE

ORBIT VALVE COMPANY

P. O. BOX 699 TULSA, OKLAHOMA

For more data on advertised products, use Readers' Service Cards, last page.

Now... SILICONES ADDED for EXTRA THREAD INSURANCE in Dragert's big D Dope

THE ONLY 90% METALLIC LEAD ALL-PURPOSE THREAD COMPOUND

AT NO EXTRA COST!

DRILLING ENGINEERS who first discovered "BIG D's" matchless sealing, lubricating, protective qualities wanted extra insurance for threads against heat and moisture. So, Dragert chemists fortified "BIG D" with the wonder-plastic SILICONE.

Now, at no extra cost, "BIG D" affords easier, quicker assembly and disassembly . . . easier, smoother application even when pipes are swimming in water.

MONEY-BACK GUARANTEE

"BIG 'D' DOPE" is MONEY-BACK GUARANTEED to afford long-lasting ISLAND HIGH lead-plating protection to all threaded fittings. Warranted anti-wash-out, anti-gall, pressure-tight sealing under the most punishing pressures, temperatures, vacuums. Guaranteed to permit quick, easy, REPEATED make-ups and break-outs WITHOUT RE-DOPING.

FREE Sample Provides Positive Proof

Order Direct or Through Oil Field or Industrial Supply Stores

C. H. DRAGERT COMPANY, INC. P. O. BOX 5092 X
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Please send me ☐ FREE brochure, "The Inside Dope on "BIG 'D' DOPE".
☐ FREE Sample of "BIG 'D' DOPE" for testing.

Name _____ Title _____

Company _____

Address _____ City and State _____

SERVING THE OIL INDUSTRY 15 YEARS

New Equipment . . .

single setting need be made to regulate the ratio of hard water to soft. Valves are automatic and adjust rapidly and surely to flow variations of one to four, without any perceptible loss in accuracy. There are no pumps and there is a minimum number of moving parts.

This simplicity is designed to keep costs down for installation, operation, and maintenance, as well as assuring a maximum of dependability.

In order to receive details on this new system of providing controlled hardness water, just . . .

Circle E9 on Postcard

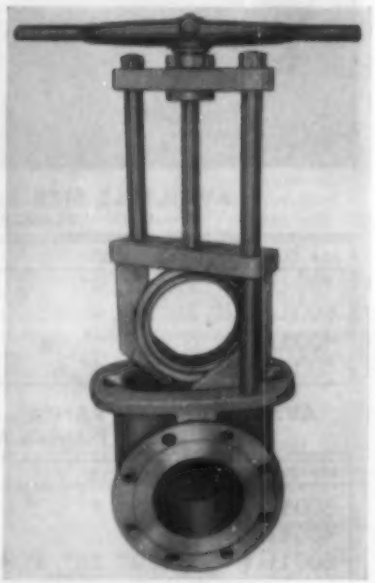
A new type chart paper with special properties which improve the legibility of instrument records have been announced by The Foxboro Company.

The new Humitex circular and strip charts, developed after years of testing and research, are printed under controlled humidity conditions on a white sulphite sheet, meeting rigid standards of uniformity and stability. Special sizing agents have been added to permit sharp, distinct recording without "feathering."

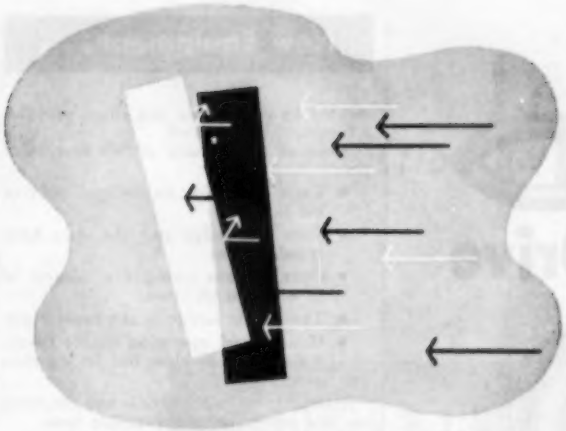
The charts were designed for use with new sediment-free Type 1500 General Purpose Ink and Type 316 stainless steel pens to provide a complete set of precision recording components for Foxboro's line of recording instruments.

Sample circular charts are available now.

Circle E10 on Postcard



A new valve which incorporates the impenetrable sealing action of a line blind with the simplicity of operation found in a gate valve has been placed on the market by Hamer Valves, Inc. This new valve, designed to permit view visibility of the wedge at all times, is appropriately named the Visible Wedge. The precision metal-to-metal fit of the wedge and seats, aug-



Radioisotope Laboratory For Oil Industry Opened in Houston!

A radioisotope laboratory solely for supplying the petroleum industry with special tagged compounds has been opened in Houston at 2419 South Boulevard by Tracerlab, Inc. The laboratory will stock and ship on 24-hour notice all the short lived isotopes and standard tagged chemicals now being extensively used, and will thus overcome present serious delivery problems.

Tracerlab has been supplying compounds to oil companies for several years from its Boston, Massachusetts and Richmond, California laboratories. The growing volume of orders has made it practical to establish a special laboratory in a location more convenient for the majority of users.

Many standard compounds utilized by the oil industry are to be packaged and sold under the firm's trade names: TraceSols, which are radioisotope solutions or volatile or gaseous compounds; and TraceOids, which are radioactive isotopes in the form of particulates. These compounds can be shipped on 24-hour notice or less, if the ordering firm's general authorization from the Atomic Energy Commission is on file.

Descriptive sheets on TraceSols and TraceOids, complete with specifications, prices and illustrations of some of the applications, are available on request.

HOUSTON LABORATORY
2419 South Boulevard, Houston, Texas, Tel.: Jackson 9401

130 HIGH STREET, BOSTON 10, MASS
Tracerlab
2030 WRIGHT AVENUE, RICHMOND 3, CALIF
WASHINGTON · NEW YORK · HOUSTON · CHICAGO · CLEVELAND · PARIS

See POSEY

For Large O. D. Low Alloy Steel PIPE

For Specialized Uses In Oil Refineries And Power Stations

You can depend on Posey to meet your requirements in large O. D. alloy steel pipe . . . and you can depend on Posey to turn out your job economically and on time.

- *Posey Alloy Steel Pipe is fabricated in accordance with ASTM specifications, Class A 155-52 aT.*
- *Posey specializes in large O. D. Pipe and Pilings of low and high alloy steel, alloy clad steel, carbon steel, and wrought iron.*

ELEVATED TANKS • HORIZONTAL TANKS • STACKS
PRESSURE VESSELS • DIGESTERS
CARBON STEEL AND ALLOY STEEL PLATE FABRICATION

POSEY IRON WORKS, INC.
Steel Plate Division
LANCASTER, PA.
New York Office: Graybar Bldg. Established Since 1910

For more data on advertised products, use Readers' Service Cards, last page.

New RIDGID 200 Tripod Power Drive

with SPEEDCHUCK

Light Weight...
Easily Quickly Set Up...
Built-In Folding Tool Tray and Folding Legs

Power for any hand pipe tools — ⅛″ to 2″ pipe, ¼″ to 2″ bolts; geared tools to 12″.

Pats. Applied For

Leg Spacing and Tool Tray assure solid rigidity, greater strength . . . No front leg to obstruct swing of die stock handles.

Fast Easy Chucking, new principle—guaranteed to grip tight both forward and reverse, won't slip, even with geared tools . . . 3-jaw centering device turns with pipe . . . Extra-powerful motor, larger brushes, longer commutator.

Your Supply House has it—
ready to demonstrate and expedite your order.

THE RIDGE TOOL COMPANY • ELYRIA, OHIO, U. S. A.

RIDGID
Work-Saver Pipe Tools

New Equipment . . .

mented by dependable seal rings, provides a foolproof line shut-off.

Some of the features of this new valve are:

- Valve seats are an integral part of the body.
- Both the wedge and the seats have stainless trim.
- Operator has complete control of of wedge at all times.
- The visible wedge is absolutely rigid.
- Hand wheel operation enable operator to open or close line in less than a minute.

Complete technical details and literature on this new valve are available now.

This item supplements Homer Valves, Inc., data on pages 467-460 of The Refinery Catalog, 22nd Edition.

Circle E11 on Postcard

A new model Comparison Bridge, to be designated E-2, is being announced by Southwestern Industrial Electronics Company.

The instrument can now be operated by an optional foot switch as well as by the conventional push button. Improved stability, accuracy and sensitivity enable resistors, capacitors and inductors to be compared over a range of 1 ohm to 5 megohms at 60 cycles. Differences as small as 1 percent may be measured on the 1 percent full scale meter range. Other scale ranges of 2½, 5, 10 and 25 percent are also provided.

In addition to its use as a comparator and go-no-go gage, the E-2 may be combined with a decade box to make quick and accurate measurements of absolute values.

Circle E12 on Postcard

The development of a new, automatic Oxy-Acetylene pipe cutting machine for formed, straight, and miter cuts has been recently announced by J. u. W. Muller Company. The machine incorporates a simultaneous combination of circular, linear and angular movements of the workpiece and cutter and it functions automatically. During the cutting operation, the cutter maintains predetermined cutting angles throughout the generated length of cut, thus eliminating any trimming or adjust-

From coast-to-coast, A. P. GREEN warehouse stocks are available for immediate delivery to your plant . . .

You Lower Your Capital Investment . . . Your capital is not tied up in warehouse space.

You Lower Your Inventory Costs . . . You have on hand only the refractories you need . . . immediately.

You Lower Your Inventory Losses . . . You buy on current prices . . . there's no danger of losing money due to price declines or breakage while in storage.

You Increase Production Space . . . By freeing storage space for more profitable use.

You Lower Labor Costs . . . A. P. Green refractories are delivered to the point of usage. There's no inplant moving by your workers.

You Maintain Steady Production . . . With less down time. A. P. Green warehouse stocks are complete and are available for immediate delivery.

THERE'S AN A. P. GREEN WAREHOUSE STOCK NEARBY

. . . to Save You Money Six Ways

Look in the classified section of your telephone directory or write for the name of the A. P. Green distributor in your locality.

A. P. Green REFRACTORY PRODUCTS

A. P. GREEN FIRE BRICK COMPANY
Mexico, Missouri, U. S. A.
PLANTS: Mexico, Mo. • Woodbridge, N. J. • Sulphur Springs, Texas
In Canada: A. P. GREEN FIRE BRICK COMPANY, LTD.
Toronto 15, Ontario

For more data on advertised products, use Readers' Service Cards, last page.

don't be HALF INFORMED

SEE

the amazing Airetool tube expansion control system ...IN ACTION!

Get a demonstration of this *precision* method of rolling perfectly bonded tube joints! The AIRETOOL Tube Expansion Control System rolls expanded joints in *half the time* normally required . . . it makes joints tight and leak-proof every time with no rerolling . . . it eliminates over-expansion and distortion of tubes. Simply set the control and go to work —it's entirely automatic.

Ideal for maintenance and production use, the AIRETOOL Tube Expansion Control System speeds fabrication of condenser and heat exchanger bundles . . . it cuts costs . . . boosts output. Contact your nearest AIRETOOL representative for a convincing demonstration.

WRITE for full details and information on AIRETOOL tube maintenance equipment suited to your particular needs.

AIRETOOL
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

Representatives in principal cities of U.S.A., Canada, Mexico, South America, England and Japan

BRANCH OFFICES: New York, Chicago, Philadelphia, Tulsa, Houston, Baton Rouge

New Equipment . . .

ment by hand on subsequent welding operations.

In operation, the pipe is mounted concentrically in the chuck, the lever operating system adjusted in accordance with requirements from precalculated figures covering diameter of tube, angle of tube axis controlling length and width of cut, and cutting angle. The torch is ignited, and the machine is started by push button. The cutting operation is completed in a few minutes at which time the machine automatically stops.

Circle E13 on Postcard

A new type of aluminum-coated steel has been developed and is being produced for commercial use by Armco Steel Corporation. Known as Armco aluminized steel (Type 2), it is designed to combine the corrosion resisting and heat reflecting qualities of aluminum with the strength of steel.

The company's first aluminum-coated steel, called aluminized steel (Type 1) has been produced exclusively by Armco for high temperature and heat reflecting applications only.

Both products are made by applying molten aluminum to cold roller sheet steel by a patented continuous pre-treatment and immersion process. General reaction of Type 2 aluminized to atmospheric exposure is the same as that of solid aluminum. Samples of both materials exposed under the same conditions for five years cannot be told apart. Type 2 aluminized is reported to have the same high reflectivity of radiant heat as aluminum—whether from the sun or from low temperature heat sources such as are used to heat buildings. The coating on aluminized steel withstands temperatures up to 900° F. with no change and temperatures up to 1250° F. without serious damage to the coating.

The cost saving is credited to the fact that the greater strength of the steel base permits use of lighter gage.

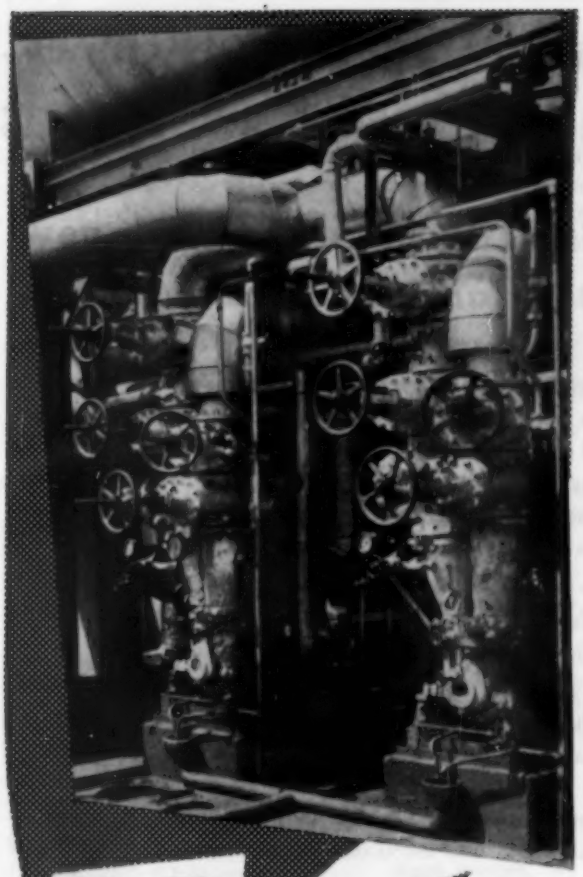
The company claims that the cost of aluminized steel will be less than the cost of galvanized steel plus one field coat of paint. According to Armco, the new aluminum-coated steel does not require painting to extend its service life.

Circle E14 on Postcard

A unique cyclone muffler, designed to capture carbon particles from the exhaust gases has been announced by The Yale & Towne Manufacturing Company. Centrifugal action is employed to throw solid particles into a collector leaving only the gases free for exhaust. When installed on gas or diesel powered trucks, the Yale cyclone muffler reduces the possibility of ignited exhaust particles as a source of ignition to combustible material.

As diesel engines have a tendency to discharge hot carbon particles, the cyclone muffler has been made standard equipment on all Yale diesel powered trucks. Although the gas engine is less likely to discharge hot solid material, the Yale cyclone muffler has also been made available at slight additional cost with this type of power for those locations where a greater fire hazard is present.

Circle E15 on Postcard



B&R

OIL REFINERIES

in many countries successfully equipped their modern plants with

- Gate Valves
- Globe Valves
- Swing Check Valves
- Safety Valves

Valves are manufactured according to API specifications. Flange dimensions conform to ASA. Materials correspond to ASTM.

One trial with our valves will make you our customer for ever.

Please ask for catalog We 110e with detailed particulars on our lines of oilfield and refinery equipment.

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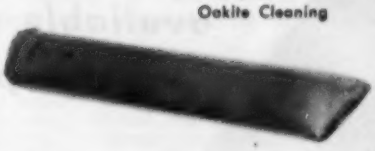


A piece of heat exchanger tubing before and after Oakite Cleaning

The BIG difference is PROCESSING EFFICIENCY

That piece of carbon-coated tubing pictured above came from the shell side of a heat exchanger bundle belonging to a large West Coast Refinery. The adjoining photo shows that same piece of tubing after it was thoroughly cleaned with specialized Oakite detergents. The contrast is striking! However, the *big* difference can't be seen.

That difference is processing efficiency.

When heavy residual oils collect on the tubing of a heat exchanger, the ability of that unit to transfer heat is cut way down . . . capacity drops . . . back pressure increases. The end result is that the overall processing efficiency of the heat exchanger falls off drastically. That's why it's so important that heat exchanger bundles be cleaned frequently and thoroughly.

Oakite made-for-the-job cleaning methods and materials provide an ideal answer to your heat exchanger cleaning problems. Oakite detergents remove soils *chemically;* they eliminate costly hand-scraping and rodding . . . do a quick, thorough job at a minimum of cost. Periodic cleaning with Oakite materials is the best guarantee you can have that heat exchangers will operate at peak processing efficiency.

Call in your local Oakite Petroleum Representative today. Let him demonstrate the modern Oakite way to get fast, economical cleaning results. Or write Oakite Products, Inc., 50B Rector Street, New York 6, N. Y.

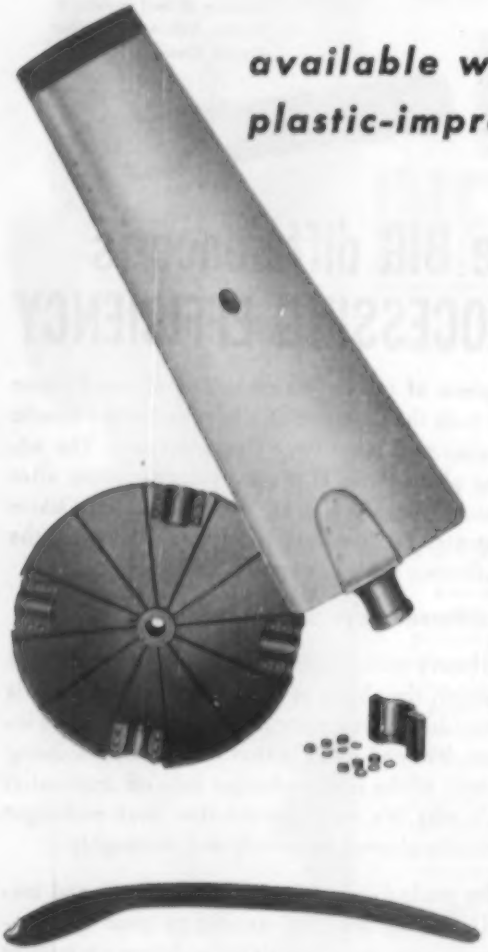
OAKITE

SCIENCE

Technical Service Representatives in Principal Cities of U. S. and Canada

New tapered-blade design boosts efficiency, increases strength of Hartzell cooling tower fans

available with either Hartzite plastic or new plastic-impregnated laminated wood blades



This cross section cut from a laminated Hartzite plastic blade shows the heavy reinforcing rib along the leading edge.

Greater efficiency and increased rigidity which reduces sag to a minimum result from Hartzell's new tapered-blade design. Blades now used on all cooling tower and heat exchanger fans in 14 to 22 foot diameters are considerably thicker at the shank than at the tip. Further strength and rigidity is provided by a rib-like reinforcement along the leading edge of the blade.

Two types of blades are available in the new design — Hartzite plastic blades as on the older designs and new plastic-impregnated wood blades.

For maximum durability and length of life, Hartzite plastic blades should be used. Fabric-reinforced Hartzite has been proved in thousands of installations since 1941 as the blade material most resistant to corrosion, vibration and abrasion. However, the new plastic-impregnated wood blades show remarkable resistance to deterioration and their initial cost will be less than that of Hartzite blades.

Both blades are of laminated construction. Hartzite blades are laminated of cured plastic sheets, and the new wood blades of 1/16" maple or birch impregnated with a special resin and covered with a plastic-setting coating. The leading edge of the wood blades is covered with an aircraft-type neoprene boot to increase resistance to abrasion.

Taper is achieved by reducing the number of laminations. A blade from a 14 foot assembly tapers from 1½" (14 laminations) at the shank to ¼" (3 laminations) at the tip.

For complete details on these rugged new fans, write today for your free copy of Bulletin A-111A.

HARTZELL

propeller fan co.

Div. of Castle Hills Corp.

Please send me a copy of Bulletin A-111A, "Hartzell Cooling Tower and Heat Exchanger Fans."

Name _____

Company _____

Street & Number _____

City & State _____

If student, check here for special information ☐

Dept. K

PIQUA, OHIO

PROPELLER-TYPE FANS • BLOWERS
ROOF VENTILATORS • UNIT HEATERS

ENGINEERING OFFICES IN PRINCIPAL CITIES

What's New in Manufacturers' Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card. Requests are transmitted to the manufacturer as soon as received by us for mailing of desired information directly to you.

Controlled volume pumps in continuous polymerization is a subject of a new application data sheet recently released by Milton Roy Company. The data sheets specifically describes the use of control volume pumps in accurate metering of several low capacity chemical flows such as modifier, catalyst, short-shop agent to the latex, anti-foam agent, and polymerization inhibitors.

Also included in this data sheet is an index of Milton Roy bulletins, engineering application data sheets, technical papers, etc.

To receive your copy of this informative data sheet, simply . . .

Circle E16 on Postcard

A portable mixer catalog, bulletin 520-P, has just been released by Eastern Industries, Inc. This new 16 page bulletin provides product information and extremely helpful engineering information, data, and diagrams. It is actually a guide to choosing the proper portable mixer and accessories for handling an extensive range of agitation jobs.

Among the units described are 420, 1125 and 1725 R.P.M. mixers, variable speed mixers, air-driven mixers, and accessories to solve special problems. Copies of this catalog are available now . . .

Circle E17 on Postcard

Welding supplies and accessories are featured in catalog 9-13 which has been recently released by Air Reduction Sales Company. Chemical analyses and mechanical properties of rods for welding mild steel, stainless steel, cast iron, bronze, brass, copper and aluminum are included in this well illustrated 36 page catalog. Also illustrated and described in the catalog are goggles, helmets, electrode holders, gloves, cables, hose, and many other welding accessories.

Copies of this informative catalog are available now . . .

Circle E18 on Postcard

"The Analysis of Chloromethanes," a new Solvay Technical Service Report, is being offered by the Solvay Process Division of Allied Chemical & Dye Corporation.

This booklet offers a comprehensive presentation of standard methods for the analysis of chloromethanes as verified and used in the company's own laboratories. One section covers the several analytical methods common to methylene chloride, chloroform and carbon tetrachloride. In addition, separate analytical procedures for each product provide individual checks for impurities normally associated with that product. Among the procedures included are methods for determining: boiling range, acidity, non-condensable or non-volatile contents, presence of methanol, carbonyl, halides, aldehydes, ketones, free halogen, etc. For your copy, just . . .

Circle E19 on Postcard

Analyses of standard carbon, alloy, and stainless tubing steels is the title of the new data folder recently published by the Tubular Products Division of The Babcock & Wilcox Company.

The folder shows the chemical analyses of the standard carbon, alloy, and stainless tubing steels used in services where elevated temperature and/or pressure are problems. It is cross-indexed to associate grade and ASTM Specifications for the individual tubing steels involved. For ready reference, the bulletin also lists the ASTM tubing and pipe specifications by number and title.

Copies of the folder are now available . . .

Circle E20 on Postcard

Packingless, self priming, centrifugal pumps, are described in bulletin G-1 just released by the LaBour Company. This 12 page, extremely well illustrated booklet features the LaBour type C-G pumps for both flooded suction and suction lift operation. Also included in the booklet is a table showing the friction head in feet for various iron pipe sizes at flow rates from five gallons per minute up to two thousand gallons per minute.

In order to receive your copy of this most informative booklet just . . .

Circle E21 on Postcard

Two new industrial X-ray units are featured in brochures now available from Balteau Electric Corporation. The units, Baltograph 120, and Baltograph 200, are designed to give maximum penetration with a minimum of weight. Flexibility as well as portability is featured in both of the units. For instance, the Baltograph 120 can be operated at voltages low enough to radiograph spot welds and light materials, yet it is powerful enough to handle moderately heavy work of more than 1 inch of steel. The Baltograph 200 has a penetration range, with intensifying screens, of up to 2½-inches of steel. The brochures describing these units should be of value to all maintenance personnel. To receive your copy, simply . . .

Circle E22 on Postcard

A general catalog on Industrial Safety Equipment is available from Willson Products, Inc. This new, easy-to-read, fully illustrated catalog is designed as a workable, everyday safety manual.

The catalog is divided into four major sections—eye protection, head protection, respiratory protection, and welding. Illustrations, descriptions, and ordering information have been correlated for simplicity and practicability. All who have an interest in industrial safety will find this new catalog a reference book of great interest and value.

To receive your copy of this new catalog, just . . .

Circle E23 on Postcard

Petroleum resins are the subjects of a new brochure now being offered by the Refining Sales Division of Kerr-McGee Oil Industries, Inc. The principal material described in the brochure, Kermac Resin 641 should find why applications in paints, varnishes, pipeline enamels, plastic compounds and wherever a pure highly refined dark resin can meet or surpass your requirements in applications now calling for high cost resins.

A copy of the brochure describing the Kermac Resin series is available now . . .

Circle E24 on Postcard

Rotating shaft sealing methods in the refining natural gasoline and petrochemical fields are described in bulletin 10, the new 12 page catalog just issued by Sealol Corporation. The illustrated catalog shows detailed diagrams of all Sealol-Flexibox standard and modified designs. This seal designed for replacement of shaft packings or for installation as original equipment works on a "balanced pressure" principle of shaft sealing, where extremely low face contact pressures in the seal are resiliently maintained by a patented spring drive.

Discussed in the catalog are 5 standard designs which handle a wide range of difficult sealing applications. Your copy of this informative bulletin is available now . . .

Circle E25 on Postcard

The 1955 edition of the G-E Instrument Transformer Buyer's Guide, containing basic, up-to-date information on the complete General Electric line has been announced as available from General Electric now.

The illustrated, 100-page publication contains ratings, ASA accuracy classification, and prices of all standard G-E indoor and outdoor potential and current transformers. Listings of ratio and phase-angle tests, tables of replacement types, and mechanical and thermal data are also included.

To receive your copy of this informative publication, just . . .

Circle E26 on Postcard

Advertisers in April Issue

A

*The Air Preheater Corp. 34
*Air Products, Inc. 88
*Airetool Manufacturing Co. 302
Allied Chemical & Dye Corp. 97
*Allis-Chalmers Manufacturing Co. 60, 27
Alloy Fabricators 273a
*Aluminum Company of America 9, 231, 273a
Aluminum Ladder Co. 265
Amercoat Corp. 64
*American Brass Co. 197
American Cyanamid Co.
Refinery Chemicals Dept. 29
American Hard Rubber Co. 196
Ansul Chemical Co. 51
Automatic Sprinkler Corp. of America 245

B

*The Babcock & Wilcox Co. 210
*The Babcock & Wilcox Co.,
Tubular Products Division 31
*Badger Manufacturing Co. 233
*Bailey Meter Co. 47
*Baldwin-Hill Co. 232
Arnold O. Beckman, Inc. 250
Bingham Pump Co. 92
*Black, Sivalls & Bryson, Inc. 16
*Blaw-Knox Co. 42
Bonney Forge & Tool Works 222
Bopp & Reuther G.m.b.H. 303a
C. F. Braun & Co. 278b
*Bridgeport Brass Co. 255
The Bristol Co. 188, 189
*Brown Fintube Co. 204
Bucyrus-Erie Co. 187
*Buell Engineering Co. 209
James Bute Co. 270
*Byron Jackson Co. 78

C

*G. O. Carlson, Inc. 275
*Carrier Corp. 72
The Chapman Valve Manufacturing Co. 71
Chase Brass & Copper Co. 54
Chemical Construction Corp. 49
Chicago Bridge & Iron Co. ..... I Cover
*Childers Manufacturing Co. 67
*Clark Bros. Co. 24-25
Classified Advertising 288, 289
Cleveland Wire Cloth & Mfg. Co. 286a
Columbia-Geneva Steel Division
United States Steel Corp. 28, 199
*Crane Co. 185
*Crane Packing Co. 241
W. H. Curtin & Co. 278c

D

Davis Engineering Corp. 228
*Dean Brothers Pumps Inc. 243
De Laval Steam Turbine Co. 240
John Dollinger, Jr., Inc. 295a
Dowell Incorporated 253
Downingtown Iron Works, Inc.
Div. Pressed Steel Tank Co. 18
C. H. Dragert Co. 298
*Dravo Corp. 273c
*Dresser Industries, Inc. 24, 205
E. I. du Pont de Nemours & Co. 98, 237, 238
*The Duraloy Co. 236
Durametallic Corp. 258a

E

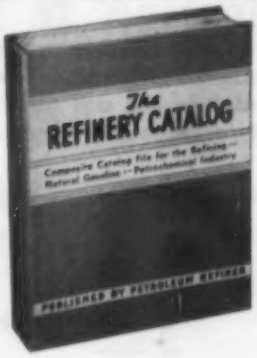
The Eagle-Picher Co. 283
Eastman Chemical Products, Inc. 97
The Electric Controller & Mfg. Co. 66
*Elliott Co. 91
*Engineers & Fabricators, Inc. 282b
*Ernst Water Column & Gage Co. 282b
Ethyl Corp. 102, 103

F

Fenwal Inc. 62
*Fisher Governor Co. 76
*Floridin Co. 272
*The Fluor Corp. 244
*Food Machinery & Chemical Corp. 41
The Foram Corp. 256
*Foster Wheeler Corp. 15
The Foxboro Co. 36

G

*Gasoline Plant Construction Corp. 77
*General American Transportation Corp. 293
General Chemical Division
Allied Chemical & Dye Corp. 97
*General Electric Co. 11, 12, 13, 14, 213
General Refractories Co. 35
Claud S. Gordon Co. 282a
A. P. Green Fire Brick Co. 301
*Grinnell Co. 48
*Gulf Publishing Co. 288b, 288b



*The asterisk preceding name of advertiser indicates that detailed data on products and services of the firm will be found in The 1954 Refinery Catalog.

Gunite Concrete & Construction Co. 276c
Gustin-Bacon Manufacturing Co. 82

H

*Hamer Valves, Inc. 280
*Harbison-Walker Refractories Co. 285
The Harshaw Chemical Co. 221
Hartzell Propeller Fan Co. 304
The Hays Corp. 58
Hercules Powder Co. 55
*Hoke, Inc. 273d
*Howe-Baker Corp. 81

I

*Ingersoll-Rand Co. 65
Insul-Mastic Corp. of America 59
*International Engineering, Inc. 292
The International Nickel Co. 6, 229
*Irving Subway Grating Co. 250
Industrial Filter & Pump Mfg. Co. 93

J

*The C. O. Jelliff Mfg. Corp. 273b
*Jones & Laughlin Steel Corp.
Supply Division 281

K

*The M. W. Kellogg Co. 56-57
*Key Co. 214
*Richard Klinger Ltd. 235
Koppers Co. 89

L

Laboratory Equipment Corp. 61
*Ladish Co. 39
Layne & Bowler, Inc. 21
Layne & Bowler Pump Co. 190
Leeds & Northrup Co. 10
LimiTorque Corp. 206
Lockheed Aircraft Corp. 239
Lukens Steel Co. 84
*The Lummus Co. 294, 194

M

*The Mack Iron Works Co. 288a
Manning, Maxwell & Moore, Inc. 246
Clayton Mark & Co. 276a
The Master Electric Co. 80
*A. Y. McDonald Mfg. Co. ..... IV Cover (4)
*Arthur G. McKee & Co. 206
The Meriam Instrument Co. 278a
Midcontinent Tube Service, Inc. 288c
*Milton Roy Co. 75
*Minneapolis-Honeywell Regulator Co. 246-247
*Mixing Equipment Co. 100
Samuel Moore & Co. 218
*Murray Iron Works Co. 254

N

National Aluminate Corp. 52
National Tube Division
United States Steel Corp. 190
Newport News Shipbuilding & Dry Dock Co. 191
Nitrogen Division
Allied Chemical & Dye Corp. 60
*Nooter Corp. 192
*Norton Co. 23

O

*Oakite Products, Inc. 303b
*Oil Well Supply Division
United States Steel Corp. 7
*Orbit Valve Co. 297

P

Panalarm Products, Inc. 201
The Ralph M. Parsons Co. 53
The Patterson Foundry & Machine Co. 296
*Peerless Pump Division
Food Machinery & Chemical Corp. 41
*Petro-Chem Development Co. 40
*The Pfaudler Co. 279
Phelps Dodge Refining Corp. 262
Philadelphia Gear Works, Inc. 200
*H. K. Porter Co., Inc. 202
*Posey Iron Works, Inc. 299b
The Wm. Powell Co. 94
*The Pressed Steel Co. 50
Pressed Steel Tank Co. 17
J. F. Pritchard & Co. 46, 269
Procon, Inc. 85

Q

The Quaker Oats Co. 264

R

*The Refinery Catalog 287
*Revere Copper and Brass Inc. 183
Reynolds Metals Co. 19, 20
Rhodia, Inc. 266
The Ridge Tool Co. 300
*Robinson Orifice Fitting Co. 198
*Rockwell Manufacturing Co. 68-69
*Rockwell Spring & Axle Co. 258b
*Rockwood Sprinkler Co. 43, 225
*Roots-Connersville Blower Corp. 205

S

Scovill Manufacturing Co. 70
Shand & Jurs Co. 257
Shell Chemical Corp. 30
*M. B. Skinner Co. 282c
A. O. Smith Corp. 44-45
Southern Engine & Pump Co. 217, 295b
Standard Oil Co. of California 37-38
*Standard Steel Spring Division
Rockwell Spring & Axle Co. 258b
Stauffer Chemical Co. 268
*Stone & Webster Engineering Corp. 203
*Sun Shipbuilding & Dry Dock Co. 242

T

*Taylor Instrument Companies 17
Tennessee Coal & Iron Division
United States Steel Corp. 28
Tennessee Corp. 284
*The Terry Steam Turbine Co. 260
Thermo Electric Co. 252
The Timken Roller Bearing Co. 8
Tracerlab, Inc. 299a
*Tretolite Co. 79
*Tube-Turns, Inc. 73-74
*Tubular Products Division
The Babcock & Wilcox Co. 31

U

*Union Asbestos & Rubber Co. 263
*United States Rubber Co. 90
United States Steel Corp. 7, 28, 199, 267
United States Steel Export Co. 28, 199
United States Steel Supply Division
United States Steel Corp. 28
*Universal Atlas Cement Co. 22
Universal Oil Products Co. 32-33

V

The Van Dorn Iron Works Co. 295c
Visco Products Co. 86
*Henry Vogt Machine Co. 251
J. H. H. Voss Co. 276b

W

Walworth Co. 63
Warren Petroleum Corp. 226
*Watson-Stillman Fittings Division
H. K. Porter Co., Inc. 202
*Western Supply Co. 26
*The Whitlock Manufacturing Co. 277
Williams Gauge Co. 186
*Worthington Corp. 259
Wright Chemical Corp. 271
Wyatt Metal & Boiler Works ..... III Cover

Y

*Yarnall-Waring Co. ..... II Cover
*Otto H. York Co. 294

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E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
E13	E14	E15	E16	E17	E18	E19	E20	E21	E22	E23	E24
E25	E26	E27									

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1	2	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
84	85	86	87	88	89	90	91	92	93	94	97	98	100	102	103	103	105	106	109
191	192	194	196	197	198	199	200	201	202	205	204	205	206	209	210	213	214	217	218
221	222	225	226	228	229	230	231	232	235	235	236	237	238	239	241	242	245	244	245
246	247	248	250	257	258a	258b	259	260	262	268	264	265	266	267	268	269	270	271	272
273a	273b	273c	273d	275	276a	276b	276c	277	278a	278b	278c	279	280	281	282a	282b	282c	283	284
285	286a	286b	287	288a	288b	288c	290	292	295	294	295a	295b	295c	296	297	298	299a	299b	300
301	302	303a	303b	304															

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E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
E13	E14	E15	E16	E17	E18	E19	E20	E21	E22	E23	E24
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24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
44	45	46	47	48	49	50	51	53	53	54	55	56	57	58	59	60	61	62	63
64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
84	85	86	87	88	89	90	91	92	93	94	97	98	100	102	103	105	106	190	
191	192	194	196	197	198	199	200	201	202	203	204	205	206	209	210	213	214	217	218
221	222	225	226	228	229	230	231	232	233	235	236	237	238	239	241	242	243	244	245
246	247	248	250	257	258a	258b	259	260	262	263	264	265	266	267	268	269	270	271	272
273a	273b	273c	273d	275	276a	276b	276c	277	278a	278b	278c	279	280	281	282a	282b	282c	283	284
285	286a	286b	287	288a	288b	288c	290	292	293	294	295a	295b	295c	296	297	298	299a	299b	300
301	302	303a	303b	304															

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• The One Purpose of Wyatt's Advertising Is to Assure Those in Need of Steel and Alloy Plate Fabrication that Wyatt Metal & Boiler Works Is a Source to Be Trusted.

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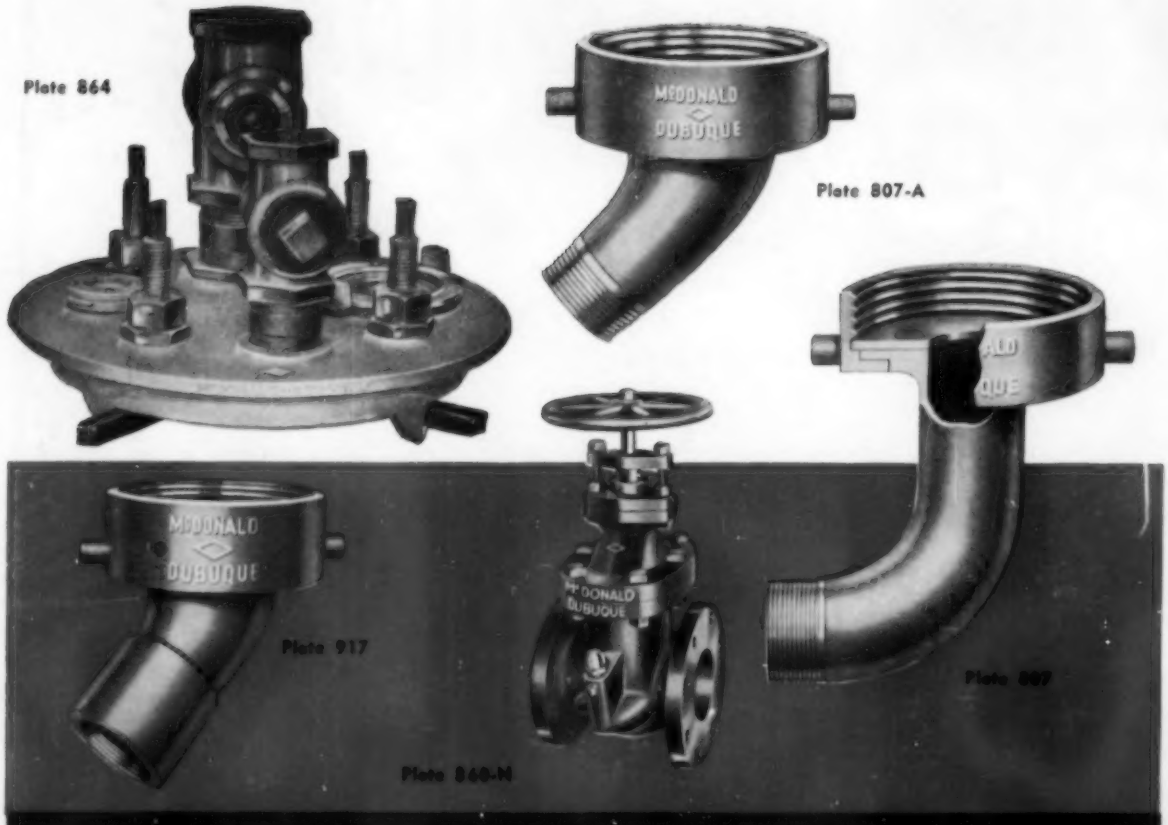

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From products of simplest design to the most intricate planning on the drawing board, following through to the ultimate of years of service McDonald equipment shows its ability to take it. Built into our equipment is not only ruggedness but also the newest and best features which men in the field tell us they want and need. It's toward this end that our engineers and production men are constantly working.

A good example of this is Plate 864, illustrated above. This cover is used when loading tank cars with gasoline — reduces evaporation losses — eliminates danger of sparks — permits loading rain or shine. Made of aluminum — permits easy handling by one man. Covers are equipped with "Peep Hole Glasses" in order that contents of car may be watched while loading.

Also produced by McDonald for tank car work are Plates 807, 807-A and 917. As you can see, the difference is the 90 and 45 degree angles, whichever you desire, with Plate 917 featuring female outlet threads. All 3 of these Tank Car Reducer Couplings are made of bronze and come equipped with a composition gasket and forged steel spanner wrench. They are offered in sizes from 5 x 2 inches up to 5 x 4 inches, with Plate 917 in sizes from 5 x 2 inches to 5 x 3 inches.

Also illustrated is Plate 860-N, a 4" flanged, non-rising stem Expansion Relief Gate Valve. When pressure in a line builds up, the disc in the by-pass opens, allowing the pressure in the line to equalize itself with that in the tank. Valve is set at 20 pounds pressure but this may be set as desired.

For further information on any of the above items or on our complete line, please write the A. Y. McDonald Mfg. Co., Dubuque, Iowa.

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